Office of the Commissioner for Aquaculture Development

OCAD
BCDA

Study No. 1

Current Status and Potential of The Canadian Aquaculture Industry

by
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FOREWORD

This study is one of seven background studies commissioned or prepared by the federal Office of the Commissioner for Aquaculture Development (OCAD) as part of its review of the federal role in aquaculture.

In order to provide a report on the federal role for the Minister of Fisheries and Oceans, the Office of the Commissioner has undertaken a series of background studies pertaining to aquaculture. The studies are:

Study 1 : Current Status and Potential of the Canadian Aquaculture Industry: a review of the context in which the Canadian aquaculture industry is evolving today, and an assessment of its potential for future growth;

Study 2 : International Fish and Seafood Markets: a Canadian perspective: a review of general trends in international fisheries products markets (commercial fisheries and aquaculture) in light of major markets targeted by Canadian aquaculture products;

Study 3 : Market Outlook in the International Fish and Seafood Sector: Alternative Products/Uses and Food Safety Issues: a review of general trends affecting the value-added of fisheries products, new uses for products derived from aquaculture and commercial fisheries (pharmaceutical products, nutraceuticals, etc.), and issues affecting food safety, especially in terms of consumer behaviour and regulatory changes affecting international trade;

Study 4 : Review of Provincial and Territorial Program and Services in the Aquaculture Sector: a review and analysis of all programs and services provided to the Canadian aquaculture sector by provincial and territorial government ministries / departments and agencies;

Study 5 : Review of Federal Programs/Initiatives in support of Aquaculture: a review and analysis of all programs and services provided to the Canadian aquaculture sector by various federal government departments and agencies;

Study 6 : Federal Programs and Services for Five Resource-Based Industries: a comparative analysis of how the aquaculture sector is treated by the Canadian government, in comparison with four other primary sectors: agriculture, forestry, commercial fisheries and biotechnology;

Study 7 : The International Context for Aquaculture Development: Growth in Production and Demand and Long-Term Outlook: a review and comparative analysis of the international context and resulting major trends that will affect the development of aquaculture at the global, national and regional levels; includes an overview of policies, governance structures, programs and services in place in various countries to provide a framework and support for industry, and to foster smooth development of aquaculture; and, the lessons for Canada.

EXECUTIVE SUMMARY

Aquaculture in Canada is undergoing continuous change. It has to compete in a global world market. The aquaculture industry in this country is facing the same driving forces that have propelled the industry to the forefront of the seafood sector in several countries around the world, notably, in Norway, Chile, Spain, and New Zealand. Worldwide, there has been a significant increase in aquaculture production while most capture fisheries have reached a plateau or are fully exploited. The demand for seafood products is growing; international competition is strong and consumer needs and expectations are constantly changing. Public scrutiny is on the rise and environmental and social concerns continue to influence the cultivation of seafood in Canada. As a result, both levels of government have increased emphasis on environmental sustainability[1], food safety and industry competitiveness while the priorities of the aquaculture sector have been on access to sites, economic viability and improved governance of aquaculture through enabling policy, social and regulatory frameworks.

Despite its relatively small size, the aquaculture industry is subject to a good deal of controversy. At the same time, aquaculture is a significant source of employment and economic wealth, particularly in rural, coastal and Aboriginal communities in Canada. It is a food production sector. It also constitutes a valuable tool for promoting rural economic development. Aquaculture represents an important means of reducing pressure on wild fish stocks as well as contributing to enjoyment of sport fishing through fish stocking activities. Moreover, it is an earner of foreign exchange through export trade in addition to being a user and developer of technology.

Despite these positive attributes, aquaculture is subject to considerable criticism by the public. This criticism relates to concerns about environmental impacts from aquaculture operations, food safety, escapements, visual or aesthetic pollution, animal welfare, navigation, price destabilization of fish and seafood markets and so on.

It is important to put the positive and the negative attributes about aquaculture in perspective so that real and perceived concerns may be adequately addressed. Firstly, we would like to review a few key statistics about aquaculture.

Production

- In 1986, Canadian aquaculture production amounted to only 10,488 tonnes, valued at $35.1 million. Aquaculture production increased on average 19.8% per year between 1986 and 2001 as a result of improved technology, investment in the sector and the expansion of global markets for aquaculture products.

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[1]Environmental sustainability: means to maintain or sustain ecosystems such that they meet the needs of the present without compromising the needs of future generations.

- The situation with respect to aquaculture has changed dramatically in Canada over the last 15 years. In 1980, shellfish represented 69% of the tonnage and 26% of the production value for aquaculture. That year, the main cultured species in tonnage were oysters 49%, trout 21%, and mussels 20%. In 2000, finfish represented respectively 74% of the tonnage and 91% of the value.

- In 2001, preliminary figures showed an important increase in aquaculture production (+14.3 %) but a slight decrease (-1.3%) in value, as a result of depressed salmon and mussel prices in export markets. That year, production reached 152,523 tonnes valued at $597 million.

- In 1999, an assessment of the economic impact of the freshwater aquaculture industry in Canada amounted to production of 9,784 tonnes that year, representing a farm gate value of $68 million. These figures represent more than a third of the tonnage and double the value of total seafood production. The sector's economic contribution is still even more significant if the recreational fishing and the freshwater components of the salmon industry are included. Industry expenses on goods and services amounted to $320 million, a GDP of over $134 million, and provided more than 1,700 person-years of employment.

Employment and Economic Benefits

- In 1998, according to Statistics Canada, there were 4,511 direct jobs generated on a national basis within the aquaculture industry.

- It is estimated that the commercial aquaculture sector provides over 14,000 jobs nationally of which more than 8,000 are in the production sector with the remainder being in the supply and services sectors. Of these direct jobs, close to 50% of the workers are less than 30 years old and the majority (over 90%) of workers live in rural and coastal communities. It should be pointed out that the official figures are believed to be significantly lower than the actual number of jobs found in the industry. Industry estimates are that 95% of aquaculture activities occur in rural/coastal areas.

Contribution to Gross Domestic Product

- Overall, aquaculture is not a particularly important sector of the national economy; it accounts for less than 1 percent of total GDP. However, the aquaculture sector is regionally important in rural and coastal communities in Atlantic Canada and on the Pacific Coast.

Decreases in Capture Fisheries

- Canada's domestic capture fishery sector has witnessed the collapse of the groundfish stocks, notably cod. Consequently, Canada has not only lost its long-time dominant ranking as a major seafood producing nation but it has also lost ground as a leading seafood trading nation. Today, Canada rates as a secondary player in the capture fisheries. In 1999, it was twenty-second in the world nation's ranking with a production of 1,021,916 tonnes.

Fish and Seafood Trade

- Canada has remained one of the world's top seafood exporters. However, its rank has dropped, passing from third in 1990 to sixth in 1997. Fish and seafood export commodities account for almost 18% of the national agri-food exports ($23.2 billion), bringing in earnings, in 2000, of $4.06 billion (459,976 tonnes), up 8.7% from 1999.

- Canada's seafood sector is heavily export-oriented, with over 75 per cent of its fish and seafood production going to more than 100 countries around the world. The United States is Canada's largest market, followed by Japan, China, the United Kingdom and Denmark. In 2000, these five destinations collectively accounted for 87.1 per cent of the volume and 90.8 per cent of the value of total seafood exports, or approximatively nine-tenths of Canadian production.

- Aquaculture exports expanded substantially during the 1990s, more than doubling between 1992 and 2000, with the United States being Canada's biggest market for aquaculture exports. Between 1998 and 2001, 98% of the mussels and 96% of the salmon produced were exported to the United States with the remainder going to France, Japan and Taiwan.

- Conversely, Canada imported $2.08 billion worth of fish and seafood products in 2000 resulting in a trade surplus of close to $2 billion.

Ranking as an Aquaculture Producer

- In 1999, Canada ranked twenty-second and accounted for only 0.3% of global production. Despite this low ranking in terms of volume, the average unit value of Canada's aquaculture products is particularly high, placing it fourth behind Japan, Chile, and Thailand.

- Aquaculture represents a growing percentage of the total domestic seafood production in this country. Increases in both finfish and shellfish aquaculture production have strengthened the seafood industry and help Canada maintain a relatively high ranking as a major seafood exporter. In 2001, aquaculture represented 12.7 % of seafood industry production. In terms of value, the difference

is even more staggering; for that year, aquaculture accounted for 25.2 % of the value of the seafood industry in Canada.

- Between 1996 and 2000, per capita consumption of fish in Canada has remained relatively stable, fluctuating between 8.3 and 10.0 kg/year.

Number and Distribution of Farms

- In 2002, there were a total of 6,116 aquaculture licences and 2,811 leases in Canada. There are 30,971 hectares of submerged Crown land under lease in Canada. There are also 164 commercial hatcheries in Canada.

Business Size and Ownership

- The aquaculture industry in Canada is composed of small and medium-sized operations as well as large-scale vertically integrated ones.

- Consolidation has been a part of the evolution of an emerging salmonid aquaculture industry trying to compete globally. This is particularly evident in British Colombia. Today, a smaller number of larger, vertically-integrated and more efficient firms are producing most of the province's farmed salmon. A small number of companies (12) own the 121 farms in operation (British Columbia Ministry of Agriculture Food and Fisheries (BCMAFF), 2002). This trend has not been as marked in the Bay of Fundy, New Brunswick, where about one-third of the total Canadian production of Atlantic salmon is produced. Corporate ownership is less concentrated in this area, where 40 companies operate 96 sites. P.E.I is the largest producer of blue mussels in Canada. The bulk of its output is processed in five mussel processing plants. It is estimated that about 90% of the aquaculture businesses in Canada are Canadian-owned. The salmon sector also has the highest level of foreign ownership.

Species Raised

- A total of 69 cold-water species are licensed for rearing in the country today. They include 51 species of finfish, 18 species of marine shellfish, two species of amphibians and two species of marine plants.

Types of Enterprises

- Farming aquatic species in Canada encompasses a wide range of containment and rearing practices, spanning freshwater, brackish and marine environments. Although a multitude of aquaculture production systems can be found, they all fall within the following three broad types of production: stocking production, food fish production or fee-fishing operations.

Industry Organizations

- The Canadian Aquaculture Industry Alliance (CAIA) is a national umbrella organization for the industry, representing Canadian aquaculture businesses, feed companies and suppliers, as well as provincial aquaculture associations.

- Member associations of CAIA include:

  1. Aquaculture Association of Nova Scotia
  2. Ontario Aquaculture Association (OAA)
  3. New Brunswick Salmon Growers Association (NBSGA)
  4. Newfoundland Aquaculture Industry Association (NAIA)
  5. Prince Edward Island Aquaculture Alliance (PEIAA)
  6. Professional Shellfish Growers Association of New Brunswick (PSGANB)
  7. Syndicat professionnel de l'Association des Aquaculteurs du Quebec (SPAAQ)
  8. British Columbia Salmon Farmers Association (BCSFA)
  9. British Columbia Shellfish Growers Association (BCSGA)
  10. Aquaculture Association of Canada (AAC)

- There are also a number of sector and provincial industry associations not affiliated with CAIA. They include:

  1. Regroupement des mariculteurs du Québec (RMQ)
  2. Alberta Fish Farmers Association (AFFA)
  3. Yukon Aquaculture Association (YAA)
  4. Aquaculture Association of New Brunswick

- One of the key challenges CAIA and its member associations are facing is the lack of stable and adequate financing. A mandatory levy on production, such as that adopted in the agriculture sector, including for the beef and pork industries, could provide a possible solution.

Biophysical Potential

- Canada is one of the important maritime nations in the world, with a coastline of 243,792 km. As well, it has 16 per cent of the world's fresh water. Because of the availability of clean water inland, as well as in the marine environment, biophysical potential for aquaculture is tremendous.

- Rearing species in a cold water environment has several advantages over rearing in a warm water environment. Aquaculture operations may adapt more readily to global warming than traditional commercial fisheries because of the flexibility to move sites and to change the species cultured.

- The aquaculture industry in Canada makes use of a relatively small surface area. The mussel industry on Prince Edward Island uses a total of 4,498 hectares of submerged Crown land. This may be compared to the surface area of Montreal's Dorval Airport, which covers an area of 7,000 hectares. In British Columbia, the entire salmon farming industry uses 1,191 hectares of tenure, which is less than the 1,340 hectares taken up by the Vancouver International Airport.

- A modest increase in the allocation of submerged Crown lands for leases would allow the aquaculture sector to expand, be more competitive and maintain market share in the U.S. In British Columbia, salmon farming production of $1 billion could be generated in an area of only four square kilometres. Simply by doubling the current shellfish tenure acreage in the province, the shellfish industry could generate up to 1,000 new jobs and farm gate value could increase from $15 million to $100 million dollars annually.

- Sea ranching[2] could generate annual landed values of $1,255 million and overall direct impacts of 15, 000 person years of employment and $900 million in GDP.

- Cod farming in Canada could be substantial. A conservative estimate of the future potential of the industry indicates that through $102 million of direct capital investment for the construction of six hatcheries and 40 nursery and grow-out farms, a total of 128, 000 tonnes of cod could be produced, worth $545 million.

Processing

- Canada has become a world leader in seafood processing. In 1998, the seafood products industry represented close to 5.5% ($2.9 billion) of total food industry manufacturing in Canada.

- In 1999, the fish processing industry accounted for 0.4% of total goods GDP but only 0.12% of all Canadian industries. The fish processing industry has declined by 15 % over the last 12 years. In 1999, there were close to 3,459 establishments (active and inactive) in seafood product preparation and packaging. Close to 2,000 establishments maintain employee payrolls. Most of them (44.8%) employ fewer than 19 individuals. There are only eight processing plants employing more than 500 employees, with the largest enterprises playing a significant role in the industry. In 1995, the eight largest firms in the processing industry, operating 9% of the plants, processed about a third of the industry's shipments.

- The seafood processing industry employs over 35,000 workers. More than 50% of the workforce is composed of women. It is a seasonal industry, geographically

[2] In this paper the term "sea ranching" means an extensive culture system of marine animals, in which hatchery systems are used to rear young individuals which are then released to forage and grow in their natural environment before they are harvested.

concentrated on both coasts of Canada (Human Resources Development Canada (HRDC) 2002).

- Between 1988 and 1996, the number of fish processing plants and related employment declined from 453 plants employing 20,000 full-time equivalent (FTE) workers to 417 plants employing an estimated 18,600 workers.

Distribution Chain

- The fish and seafood distribution networks in the United States consist mainly of three channels, notably brokers, wholesalers and retailers. In the United States, food brokers most often sell food products, with wholesale clubs and retailers emerging as important buyers. Today, they represent the most important buyers from processors in Atlantic Canada. Primarily, it is wholesalers (76%), followed by processors (19%) and fishery companies (5%) that distribute imports of seafood products within the United States. The purchasing decisions made by these groups and such decisions relating to the Canadian domestic market are strongly driven by packaging, price and advertising.

Proximity to U.S. and Asian Markets

- Canada's location means it has easy access to the huge North American and Pacific Rim fish and seafood markets. The United States is, in fact, Canada's largest export market. The proximity of Canada to U.S. aquaculture and seafood markets is advantageous in terms of freight costs and maintaining continuity of supply. The relative low value of its currency is a further advantage for exports.

- Following the events of September 11, 2001, in the U.S., there was a significant increase in air cargo prices. More stringent aircraft security has resulted in an increase of almost 20 per cent in transport costs. Compared to its Chilean counterparts, because of its close proximity to the U.S., the Canadian salmon farming industry has felt less pressure on its profit margins in relation to exports to that country. While the situation has improved greatly in the first quarter of 2002, the events of September 2001 have had important impacts on seafood exports. The key related issues are the openness of the border between the U.S. and Canada, ensuring national security and that measures taken at the border do not impede trade and investment. One of the biggest concerns has been the perception that Canada is a security risk.

Expertise and Reputation in Environmentally Sustainable Technologies and Practices

- Public concern over the state of the environment and regulatory requirements established in response to these concerns has led to the emergence of an environmental industry in Canada. In fact, its success has been remarkable. In a

relatively short time Canada has been able to position itself as an international expert with a solid reputation in the fields of environmental technology and sustainable development.

- A sense of environmental responsibility is emerging within the country and is being put into practice through the creation of integrated environmental management systems. Canada's commitment to being recognized as an international leader in sustainable aquaculture development is strong. Continued efforts will provide an excellent opportunity to further position the country as a model of sustainable aquaculture and allow aquaculture to become one of Canada's sub-sector industries.

It is clear that aquaculture represents the future of the domestic fish and seafood industry and the Canadian aquaculture industry continues to experience substantial rates of growth. Between 1997 and 2001, Canadian aquaculture production grew, on average, at a rate of 17%. If Canada is to regain its status as one of the leading producer nations, then both seafood sectors, fisheries and aquaculture, must collaborate more closely. Aquaculture can help improve the country's position on the international scene as a major producer and exporter of fish and seafood.

Using very conservative forecast assumptions, it is estimated that the Canadian aquaculture industry will likely grow from its current revenue level of $700 million to at least $3.1 billion in 2010, provided that an enabling policy and regulatory environment exists. Combined with the supply and services industry, the aquaculture sector could generate total revenues in excess of $6 billion.

It is equally clear that as aquaculture grows, opposition emerges to some of its practices. At the same time, environmental non-government organizations (ENGOs), recreational property owners, representatives of commercial fishers and some Aboriginal leaders have played an important role in identifying concerns, bringing these to the attention of governments and contributing to solutions.

For Canadian aquaculture to meet the challenge of achieving its potential there must be a framework in place that satisfies not only traditional investment criteria but also public expectations for sustainable development. If this can be achieved, Canada would be unique in having an aquaculture industry that has earned its social licence by respecting environmental social and cultural concerns of its neighbours.

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INTRODUCTION

Aquaculture in Canada is undergoing continuous change. It has to compete in a global world market. The aquaculture sector throughout Canada is facing the same driving forces that have propelled aquaculture to the forefront of the seafood sector in several countries around the world, notably in Norway, Chile, Spain, and New Zealand. Globally, we have witnessed a significant increase in aquaculture production worldwide while most capture fisheries have reached a plateau or are fully exploited. At the same time, there is a growing demand for seafood products, strong international competition and constant change in consumer needs and expectations. In Canada, pressures to globalize aquaculture production as well as increased public scrutiny have forced both levels of government and industry to begin to respond more effectively to emerging development trends and challenges relating to development.

Public scrutiny is on the rise and environmental and social concerns continue to influence the cultivation of seafood in Canada. We have witnessed increased emphasis from both levels of government on environmental sustainability, food safety and industry competitiveness while priorities for the aquaculture sector have been on access to sites, economic sustainability and improved governance of aquaculture through enabling policy, social and regulatory frameworks.

OCAD's core mandate is to prepare a 15-year strategic vision for the Canadian aquaculture sector together with proposed options and recommendations to the Minister of Fisheries and Oceans. In the process of crafting an appropriate federal role to achieve this vision, we must fully understand the current Canadian context within which the sector is evolving and have a good knowledge of the future potential of aquaculture in this country. For the sector, achieving its full potential means adapting and responding to emerging challenges, capitalizing on strengths and taking advantage of opportunities.

The purpose of this study is to provide the reader with an overview of the present and future status of aquaculture in Canada. Part I presents the current status of the domestic aquaculture industry. Firstly, it examines the economic benefits related to aquaculture. National trends in aquaculture production value and tonnage and recent production figures by environment type, species and province are reviewed. Employment and economic benefits, contribution of the sector to the Gross Domestic Product (GDP) and Canada's fish and seafood trade are also covered. Secondly, a description of the industry is provided. The number and distribution of farms; the business size and ownership; the species being raised; the enterprise types and industry organization are discussed. Finally, current issues such as food safety, environmental sustainability, access to sites, industry competitiveness are identified and briefly described.

Part II provides an analysis of the potential for aquaculture in Canada. It begins with an assessment of the biophysical potential, followed by a discussion of Canadian know-

how and expertise in international markets. The information includes a review of the seafood processing sector and distribution chain. The benefits of Canada's proximity to U.S. and Asian markets for export of our aquaculture products are also discussed. Lastly, the emerging opportunity to create an environmental aquaculture sub-sector by building on Canada's expertise and reputation in environmentally sustainable technologies and practices is examined.

PART 1

CURRENT STATUS OF THE CANADIAN AQUACULTURE INDUSTRY

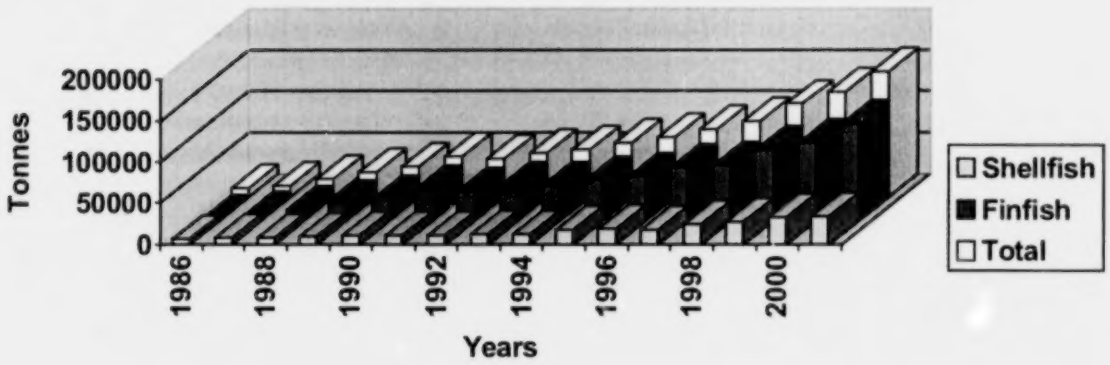
CURRENT STATUS OF THE CANADIAN AQUACULTURE INDUSTRY

Economic importance

Production

The Canadian aquaculture industry is only a few decades old but it has experienced phenomenal growth. The sector has evolved from a cottage industry to become a significant economic driver in a number of rural and coastal areas. In 1986, Canadian aquaculture production amounted to only 10,488 tonnes, valued at $35.1 million. Aquaculture production increased on average 19.8% per year between 1986 and 2001 as a result of improved technology, investment in the sector and the expansion of global markets for aquaculture products (Figure 1). The largest annual growth was recorded in 1988 when there was a 53.9% increase in production over the previous year, with this growth being mainly attributable to a substantial increase in salmon (Atlantic, chinook and coho) production.

FIGURE 1 - CANADIAN AQUACULTURE PRODUCTIO (1986-2001)



Source : Fisheries and Oceans Canada (DFO), Statistics Canada

The situation of aquaculture has changed drastically in Canada over a 15-year span. In 1986, shellfish represented respectively 69% of the tonnage and 26% of the production value. That year, the top five species generated 99.9% of the tonnage and 99.9% of the value. The main cultured species in tonnage were oysters 49%, trout 21%, mussels 20%, salmon 10% and steelhead 0.09% (Table 1).

TABLE 1 – TOP FIVE SPECIES IN AQUACULTURE PRODUCTION (1986)				
Species	Production in 1986	Value in 1986	Percentage of Canadian Production	
	('000 tonnes)	('$000)	(99.9% of tonnage and 99.9% of value for top five species)	
Oysters	5,164	5,752	49.2	16.4
Trout	2,167	14,554	20.7	41.5
Mussels	2,062	3,427	19.7	9.8
Salmon	1,073	11,271	10.2	32.1
Steelhead	9	72	0.09	0.2

Sources: DFO, Statistics Canada.

In 2001, aquaculture production was valued at $597 million at the farm gate level and reached 152,523 tonnes (Tables 2 and 3), of which 97.6% was generated by the top five species: salmon 69.0%, blue mussels 14.2%, oysters 7.0%, trout 4.3% and steelhead 3.1% (Table 4). In 2001, an important increase in production (+ 19.9 %) was observed, coupled with a slight decrease (- 0.5%) in value (Tables 2 and 3). This reduction in value is a direct result of depressed salmon and mussel prices in the export market (PriceWaterhouseCoopers, 2002).

In 2001, finfish represented respectively 77% of the tonnage and 90% of the value of the Canadian output (Figures 2 and 3). Finfish production increased to 118,161 tonnes in 2001, an increase of 24.5% over the previous year, while shellfish production increased 6.3% from 32,339 to 34,362 tonnes over the same period (Table 2). In terms of the percentage change in value, the figures for finfish and shellfish were respectively of -1.6% and +10.6% (Table 5). The increase in salmon production (27.1%) originated mainly in British Colombia, which, in 2001 produced 18,700 tonnes more than in the previous year. New Brunswick, the second largest producer of salmon in the country, saw its production increase by 14.2% (4,800 tonnes).

In 2001, shellfish production in Canada reached 34,362 tonnes, worth $58.1 million. This represents an increase of +6.3% in tonnage and +10.6% in value over 2000. This increase for shellfish was mainly from oysters in British Columbia. Prince Edward Island remains the largest mussel producer in Canada. In 2001, it accounted for 81.8% of total production. In that year, P.E.I produced 17,506 tonnes of mussels valued at $23.2 million, followed by Nova Scotia (7.5%), Newfoundland (6.7%), New Brunswick (3.5%) and Quebec (1.6%). In 2001, clam production in British Columbia was valued at $7.7 million, an increase in volume of 40%, for total production of 1,400 tonnes over the previous year (Tables 2 and 3).

TABLE 2 - AQUACULTURE PRODUCTION IN TONNES BY PROVINCE AND SPECIES IN 2001

	Salmon	Trout	Steelhead	Total Finfish[3]	Clams	Oysters	Mussels	Other	Total Shellfish	Total
Newfoundland	1 092	-	1 719	2 811	-	-	1 452	-	1 452	**4 263**
Nova Scotia	2 614	-	2 986	5 600	-	438	1 619	410	2 467	**8 067**
Prince Ed. Island	X	X	-	76	-	2 731	17 506	-	20 237	**20 313**
New Brunswick	33 900	550	-	34 450	-	744	750	-	1 494	**35 944**
Quebec[4]	-	875	-	875	-	-	339	53	392	**1 267**
Ontario	-	4 100	-	4 100	-	-	-	-	-	**4 100**
Manitoba	-	16	-	16	-	-	-	-	-	**16**
Saskatchewan	-	875	-	875	-	-	-	-	-	**875**
Alberta	-	X	-	X	-	-	-	-	-	**X**
British Columbia	67 700	100	-	67 800	1 400	6 800	-	120	8 320	**76 120**
Total 2001	**105 306[2]**	**6 516[2]**	**4 705[2]**	**118 161[3]**	**1 400**	**10 713**	**21 666[2]**	**583[2]**	**34 362**	**152 523[1]**
Change	**+ 27.1%**	**+ 1.7%**	**- 14.8%**	**+ 24.5%**	**+40.0%**	**+ 11.3%**	**+ 1.8%**	**+ 36.2%**	**+ 6.3%**	**+ 19.9%**
Total 2000	82 195[2]	6 407[2]	5 523[2]	94 895[3]	1 000	9 624	21 287[2]	428[2]	32 339	**127 234[1]**
Change	+ 12.8%	- 2.6%	- 8.0%	+ 10.2%	+ 25.0%	+ 9.6%	+ 22.4%	+ 345.8%	+ 19.4%	**+ 12.4%**
Total 1999	72 890[2]	6 581[2]	6 002[2]	86 150[3]	800	8 785	17 397[2]	96[2]	27 078	**113 228[1]**
Change	+ 24.4%	+ 10.4%	+ 155.0%	+ 27.8%	+ 14.8%	+ 8.0%	+ 15.8%	- 17.9%	+ 12.9%	**+ 23.9%**
Total 1998	58 618[2]	5 962[2]	2 354[2]	67 435[3]	704	8 137	15 018[2]	117[2]	23 976	**91 411[1]**
Change	+ 3.2%	+ 0.9%	+ 148.8%	+5.6%	+ 8.5%	+ 44.5%	+ 29.8%	+ 64.8%	+ 33.8%	**+ 11.8%**
Total 1997	56 775[2]	5 910[2]	946[2]	63 842[3]	649	5 631	11 570[2]	71[2]	17 921	**81 763[1]**

Source: Modified from Statistics Canada

(1) Includes Char, Other Finfish and Total Alberta Finfish – 1,558; 694; 595; 402; and 117 tonnes respectively in 2001, 2000, 1999, 1998 and 1997.
(2) Excludes confidential data
(3) Excludes "Other" for provinces
(4) The official government of Quebec freshwater aquaculture statistics are much higher. In 2001, the production figure was 1,955 tonnes representing a value of $15.9 million. A total of 972 tonnes was produced for the purpose of stocking while the remainder was produced for human consumption or for sale from fish ponds. The two major finfish species produced in 2001 were brook trout (39.5%) and rainbow trout (53.9%).

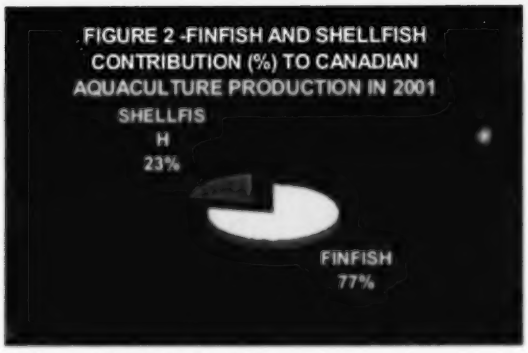
TABLE 3 - AQUACULTURE FARM GATE VALUE[4] ($'000) BY PROVINCE AND SPECIES IN 2001

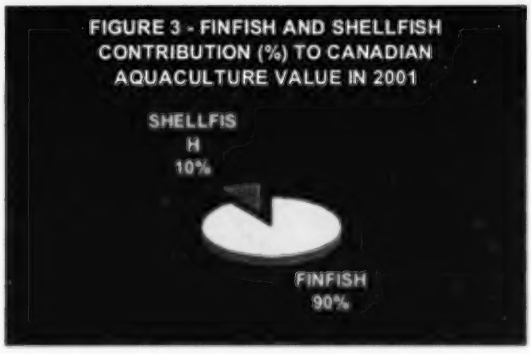
	Salmon	Trout	Steelhead	Total Finfish[2]	Clams	Oysters	Mussels	Other	Total Shellfish	Total
Newfoundland	5 200	-	9 752	14 952	-	-	3 929	-	3 929	**18 881**
Nova Scotia	14 361	-	9 777	24 138	-	1 327	2 002	2 184	5 513	**29 651**
Prince Edward Island	X	X	-	773	-	6 324	23 200	-	29 524	**30 257**
New Brunswick	180 010	6 100	-	186 110	-	2 040	825	-	2 865	**188 975**
Quebec[5]	-	4 674	-	4 674	-	-	543	82	625	**5 299**
Ontario	-	16 900	-	16 900	-	-	-	-	-	**16 900**
Manitoba	-	62	-	62	-	-	-	-	-	**62**
Saskatchewan	-	3 859	-	3 859	-	-	-	-	-	**3859**
Alberta	-	X	-	X	-	-	-	-	-	**X**
British Columbia	269 400	500	-	269 900	7 700	7 300	-	700	15 700	**285 600**
Total 2001	**468 971[3]**	**32 095[2]**	**19 529[2]**	**538 987[1]**	**7 700**	**16 991**	**30 499[2]**	**2 966[2]**	**58 156**	**597 143[1]**
Change	**- 3.1%**	**+ 1.4%**	**-21.5%**	**- 1.6%**	**+16.7%**	**+ 2.8%**	**+ 12.1%**	**+32.6%**	**+10.6%**	**- 0.5%**
Total 2000	483 755[2]	31 660[2]	24 889[2]	547 807[1]	6 600	16 515	27 213[2]	2 237[2]	52 565	**600 372[1]**
Change	+ 7.5%	- 1.2%	- 13.4%	+ 6.0%	+ 57.1%	+ 24.4%	+ 17.1%	+ 567.8%	+ 28.0%	**+ 7.6%**
Total 1999	450 084[2]	32 047[2]	28 754[2]	516 847[1]	4 200	13 278	23 244[2]	335[2]	41 057	**557 904[1]**
Change	+ 28.9%	+ 14.2%	+ 120.9%	+ 30.9%	+ 16.1%	+ 17.3%	+ 22.4%	- 53.7%	+ 18.5%	**+ 29.9%**
Total 1998	349 043[2]	28 058[2]	13 014[2]	394 859[1]	3 619	11 321	18 985[2]	723[2]	34 648	**429 507[1]**
Change	+ 7.7%	- 3.1%	+ 212.9%	+ 10.1%	+ 24.7%	+ 30.2%	+ 37.6%	+ 108.9%	+ 34.6%	**+ 11.7%**
Total 1997	324 030[2]	28 952[2]	4 158[2]	358 664[1]	2 902	8 695	13 798[2]	346[2]	25 741	**384 405[1]**

Source: Modified from Statistics Canada

The value of aquaculture excludes hatcheries or value-added products.

(1) Includes Char, Other Finfish and Total Alberta Finfish – 1,558; 694; 595,402; and 117 tonnes respectively in 2001, 2000, 1999, 1998 and 1997.
(2) Excludes confidential data
(3) Excludes "Other" for provinces
(4) "Farm gate value" means the value of cultivated products at the producer level
(5) The official government statistics are much higher. In 2001, the value of the freshwater aquaculture industry was $15.9 million.





Source: Statistics Canada

TABLE 4 – TOP FIVE SPECIES IN AQUACULTURE PRODUCTION (2001)

Species	Production in 2001	Value in 2001	Percentage of Canadian Production	
	('000 tons)	('$000)	(97.6% of tonnage and 95.1% of value for top five species)	
Salmon	105,306	468,971	69.0	78.5
Blue Mussels	21,666	30,499	14.2	5.1
Oysters	10,713	16,991	7.0	2.8
Trout	6,516	32,095	4.3	5.4
Steelhead	4,705	19,529	3.1	3.3

Source: Statistics Canada

TABLE 5 – CHANGE IN CANADIAN AQUACULTURE PRODUCTION BETWEEN 2000 AND 2001

Species	Production		Value		Percentage Change in Production and Value	
	2001	2000	2001	2000		
	('000 tonnes)		('$000)		%	
Finfish	118,161	94,895	538,987	547,807	24.5	- 1.6
Shellfish	34,362	32,339	58,156	52,565	6.3	10.6
Total	152,523	127,234	597,143	600,372	19.9	- 0.5

Source: DFO, Statistics Canada

In 1999, an assessment of the economic impact of the freshwater aquaculture industry in Canada showed that 9,784 tonnes of product were produced that year, representing a farm gate value of $68 million. These figures represent more than a third of the tonnage and double the value of the amounts shown in Statistics Canada figures. Two-thirds of the production was destined for food consumption markets while the remaining was destined for lake and stream stocking. Brook trout, rainbow trout and, to a lesser extent, Arctic char are the main species being raised in freshwater. The freshwater sector generated $93 million in expenditures on goods and services; it also contributed $59 million to GDP and generated 1,300 full-time equivalent direct and indirect jobs. The economic contribution of the sector is still more significant if the recreational fishing and the freshwater component of the salmon industry are taken into account. The related expenses represent $320 million, a GDP impact of more than $134 million and more than 1,700 person-years of employment (Charron et al., 2001).

In 2000, Canadian production of Arctic char was estimated at 970 tonnes. Canada is ranked second in the world after Iceland, which produced 1,100 tonnes that year. The species is produced mainly in the Maritimes (42%), Quebec (21%), Yukon (19%) and Ontario (16%). The remaining three percent is being produced in Alberta and Manitoba (Rogers and Davidson, 2001).

Employment and Economic Benefits

According to Statistics Canada, there were 4,511 direct jobs generated on a national basis within the aquaculture industry in 1998. Table 6 sets out the employment and salary figures for medium-sized and large farms involved in aquaculture production by province for the period 1997 to 2000. In 2000, there were 3,850 jobs in aquaculture production in Canada. Salaries paid to aquaculture workers amounted to $90 million that year. Since 1997, the number of jobs increased by close to 16% while there was a 25% increase in total salaries paid to employees of medium-sized and large aquaculture farms. In 2000, British Columbia and New Brunswick alone accounted for 61% of the workers in the aquaculture industry.

It should be noted that the official figures on employment are believed to be significantly lower than the actual number of jobs in the industry. The sample design used in Statistics Canada's aquaculture survey does not take into consideration that the owners of numerous small shellfish and trout operations account for a significant portion of the workforce in the aquaculture industry. Moreover, only aquaculture establishments with gross business revenue greater than or equal to a cut-off that fluctuates on a provincial basis between $30,000 and $250,000 are used to derive Statistics Canada's employment estimates. During the winter of 2003, a labour force survey of the Canadian aquaculture industry, jointly funded by OCAD and the Canadian Aquaculture Industry Alliance (CAIA), is to be carried out by a researcher from the University of British Columbia. The results of the survey should provide up-to-date information about the number of direct jobs in the sector.

TABLE 6 – EMPLOYMENT AND SALARY FIGURES FOR MEDIUM AND LARGE FARMS INVOLVED IN AQUACULTURE PRODUCTION BY PROVINCE (1997-2000)								
	2000		1999		1998		1997	
PROVINCES	Number of Jobs	Salary '$000	Number of Jobs	Salary '$000	Number of Jobs	Salary '$000	Number of Jobs	Salary '$000
Newfoundland[1]	210	2800	220	3200	220	3000	200	2300
Prince Edward Island[1]	600	10000	570	9000	550	8000	500	6500
Nova Scotia[2]	350	8000	350	7500	300	6000	170	4000
New Brunswick[3]	1045	26000	1000	25000	780	20000	820	23200
Quebec[1]	150	2200	150	2200	125	1800	120	1700
Ontario[1]	195	4000	210	3900	220	4000	220	4000
British Columbia[3]	1300	37000	1300	35000	1200	30500	1300	30000
Canada	**3850**	**90000**	**3800**	**85800**	**3395**	**73300**	**3330**	**71700**

Source: Statistics Canada

The number of jobs includes farmers for whom the amount of revenue (in dollars) exceeds the following limits: (1) $46,000; (2) $70,000 and (3) $250,000. Jobs include full-time, part-time and temporary workers but not autonomous workers. The data provided are experimental and subject to revisions, and should be used with caution.

According to the Nova Scotia Department of Fisheries and Aquaculture, there were 1,095 full-time and part-time jobs generated by the aquaculture industry in the province in the year 2000. Statistics Canada figures for 2000 are two-thirds lower, indicating 350 jobs. In 2000, salmon farm employment in British Columbia was estimated at 3,400 direct and indirect jobs (British Columbia Salmon Farmers Association, 2002). The Statistics Canada figure for B.C. is 1,300 jobs in 2000.These examples illustrate the discrepancies in the aquaculture employment figures that are available. It is estimated that the commercial aquaculture sector provides over 14,000 jobs nationally, of which more than 8,000 are in the production sector with the remainder being in the supply and services sectors (OCAD, 2002). With respect to these direct jobs, close to 50% of those employed are under 30 years old and the majority (over 90%) of workers live in rural and coastal communities (DFO, 2002). A recent economic analysis of the salmon farming sector in Charlotte County, New Brunswick, indicates that 75% of the employees are under 40 years old (Cooke and Steward, 2001).

Jobs in the aquaculture sector are filled on a permanent full-time, part-time or seasonal basis. The workforce is composed of individuals with a wide range of skills and

competencies such as fish farm laborers, divers and boat operators, hatchery employees, fish feed producers, transportation and processing plant workers, professional service providers, such as researchers, accountants, lawyers and veterinarians, and finally marketing, sales and administrative employees.

Aquaculture is a decidedly rural industry. Industry estimates are that 95% of aquaculture activities occur in rural/coastal areas. The decline in population in rural areas to the benefit of urban centres is a reality in many parts of the country. Aquaculture companies across Canada represent a vital contributor to rural and coastal economic growth, thus enabling young people to stay and prosper in their communities rather than having to move elsewhere. The value of the aquaculture industry's contribution to the economy of coastal areas is not always fully recognized. "*Nevertheless, its contribution is extremely significant, all the more so given that the sector is a substitute to the decline of traditional fishing resources and at the same time it helps diversify regional employment.*" (Beaudin, 2001).

The aquaculture sector requires a skilled workforce. In aquaculture, the majority of jobs are well-paying. As an alternative activity, aquaculture is still at a preliminary stage of economic development in several geographical areas but is of enormous significance for the future. There is also potential for increased well-being of coastal communities and First Nations. Limited government intervention will be required to realize the full potential of aquaculture for the economies of rural and coastal communities, while ensuring that environmental sustainability is respected. Several examples of what can be achieved as a result of the development of aquaculture are set out below.

New Brunswick

Over the last decade, Charlotte County, which is located in the southwestern part of the province, has experienced significant growth in its economy. This economic prosperity is due to the aquaculture industry, and, specifically, to salmon farming. While this rural area was previously faced with high levels of unemployment, the current situation is very different. The county has become a significant hub for Canadian aquaculture production. The success has been so significant that it became necessary to recruit workers from other parts of New Brunswick and elsewhere to meet the shortage of manpower (OCAD, 2002). Several of Charlotte County's largest employers are found in the aquaculture sector (Fundy Region Development Commission Inc., 2002). The industry generates over 3,000 full time jobs in the local area, which represents 25% of the entire workforce (Cooke and Steward, 2001 and ACOA, 2001). Moreover, the spin-off industries such as boat building, machine shops, and manufacturing also contribute to the economy. It is estimated that for every direct job in the industry, two-thirds of a job is created in the support service sector and on the supply side (OCAD, 2002).

The salmon net pen culture industry is currently providing even more full-time employment in the province of New Brunswick than it did in the mid-1990s. According to a recent economic study, there are a total of 3,005 jobs overall in Charlotte County related to aquaculture, of which 1,683 are direct jobs and 1,322 are indirect jobs. The

locations of direct jobs can be broken down as follows: 19 hatcheries (157 employees), 96 marine sites (603 employees), 10 processing plants (516 jobs), 10 sales/marketing locations (125 employees) and direct services (240 employees). In 2000, total wages represented an injection of close to $41 million into the local economy (Rayner, 2001). In the past five years, full-time jobs have increased by 82 per cent. At the same time, the authors of the study that Rayner refers to observed a decline in part-time employment and seasonal workers of 26 percent and 10 percent respectively. During that period, processing plants have expanded in size, diversified their product lines and provided the majority of new jobs. In fact, the processing sector supplied 68 per cent more jobs than it did five years ago (Rayner, 2001).

Newfoundland

Another example of vibrant success is the Coast of Bays region, Newfoundland. Located on the South Coast of Newfoundland, the Coast of Bays region is composed of 22 communities, ranging from 194 to 2,290 residents. Over the last decade, most coastal communities in the province have experienced a steady decline in population. Unless new opportunities such as aquaculture are developed, it is believed the trends in population loss will continue (Coast of Bays Corporation, 2001). The Coast of Bays region has experienced a drastic increase in unemployment and an economic downturn as a result of the collapse of the cod fishery. Aquaculture is without any doubt seen as a viable alternative to maintain the fabric and livelihood of those communities. The potential for new wealth generation and job creation is impressive. Currently, an estimated 150 full-time jobs and another 60 part-time jobs are generated by the sector. Local businesses in the community can attest to the importance of aquaculture for their survival (Newfoundland Salmonid Growers Association, 2001). Aquaculture offers people jobs, attracts families, and helps keep coastal communities alive.

British Columbia

The Alberni-Clayoquot Sound, Comox-Strathcona and Northern Vancouver Island, areas of British Columbia, are also flourishing because of aquaculture development. British Columbia's fish farming industry provides 1,800 full-time and year-round direct jobs and an additional 2,000 indirect and induced jobs (British Columbia Salmon Farmers Association, 2001). The sector is a major economic contributor to local economies, mainly in these areas. The majority of the people employed, over 92% of the total workforce, lives in coastal communities outside of the greater Victoria and Vancouver areas. Salmon farming strengthens the diversity and stability of these coastal communities. Fish farm and grow-out workers hold most of the direct jobs (61%) followed by workers in processing plants (16%), hatcheries (10%), in marketing and administration (10%) and marine transport (3%). It is estimated that every hectare of finfish in production can generate $2 million worth of salmon per year and create 40 full-time jobs.

First Nations

The number of First Nations involved in aquaculture has been increasing in the last few years. First Nations are turning to aquaculture to create opportunities for their members. The aquaculture jobs generated within First Nations are a source of community pride; they foster economic growth, employment and job diversification. Moreover, they assist First Nations in striving towards self-sufficiency. The Miawpukek (Nfld.), Eskasoni (N.S.), Eel River Bar (N.B.), Rainy River, Sucker Creek, Wikwemikong, Nawash (Ont.), Ahousaht, Klahouse, Quatsino, Snuneymuxw, Kitasoo, Metlakatla, Xaixaia, Tla-o-quiat, Sliammon, Kitkatla, Kyuquot, Ehattesaht (B.C.) First Nations are all involved in the aquaculture industry. These First Nations raise a number of species of finfish (Atlantic salmon, steelhead, rainbow trout, sturgeon) and shellfish (Manila clams, Pacific and American oysters, Japanese scallops and abalone). In B.C., close to 57 percent of the 924 hectares allocated for new shellfish tenures has been approved for First Nations, thus ensuring significant Aboriginal involvement in the industry (Webb, 2001).

Examples of First Nations success stories in aquaculture involve the Kitasoo/Xaixais and Sucker Creek Nations. The Kitsaoo/Xaixais First Nation is located in the remote coastal community of Klemtu, on the Central Coast of British Columbia. This small island community of about 380 residents has been experiencing a chronic high unemployment rate, reaching 80% during the winter months. In 2000, through the Western Economic Diversification Canada, the Kitasoo/Xaixais Nation has received a $250,000 repayable contribution towards a $383,293 project. The funds were used for modifications and upgrading of the local processing plant and for salmon aquaculture education and training (Western Economic Diversification Canada, 2000). The education and training component of the project represents an innovative approach. The partnership model developed could be applied on a broader scale for linking remote First Nations communities with non-Aboriginal ones using distance delivery technology. The Kitasoo/Xaixais First Nation, North Island College and Nutreco Canada Inc. have entered into a partnership to develop and provide the delivery of a comprehensive on-site salmon distance education module for training members of the Kitasoo/Xaixais First Nation either on the reserve or at adjacent salmon farms.

The agreement was designed to alleviate the problem of shortages in skilled labour in the area and to give priority to jobs for qualified local residents at the existing Nutreco operation (Marine Harvest Canada) and at three new farms being developed (Robert, 2000). This initiative will provide needed jobs in the community. In fact, the employment figures have improved substantially in the village of Klemtu. It is estimated that 30 full-time farm jobs and 30 full-time processing jobs will be created over a period of three to five years. Direct wages to skilled laborers will generate close to $4.2 million dollars during the period (Western Economic Diversification, 2000).

Contribution to Gross Domestic Product (GDP)

The Gross Domestic Product (GDP) represents the total market value of all final goods and services produced in a country in a given year. It equals total consumer, investment and government spending, plus the value of exports minus the value of imports. It is the standard measure of the overall size of the economy (Government of Canada, 2002b).

Agri-food is one of Canada's top five industries and accounts for about 8.5% of Canadian Gross Domestic Product (GDP) (Agriculture and Agri-Food Canada, 2002). Aquaculture is not a particularly important sector of the national economy; it accounts for less than one percent of total GDP. However, the aquaculture sector is regionally important in rural and coastal communities in Atlantic Canada and on the Pacific Coast.

The Canadian aquaculture industry value-added account is presented in Table 7. The value-added account measures the value of the economic production of goods and services directly from aquaculture businesses. The national aquaculture gross output increased by close to 51 % between 1997 and 2000 from $511.3 million to $774.7 million. In 2000, sales of products and services represented 90% ($691.3 million) of the aquaculture industry gross output to the Canadian economy. Finfish products constitute the bulk of the sales with 91%. Feed is the largest product expense representing about 40% of total production cost followed by the purchase of eggs and fish for grow-out at just over 12%. In 2000, $90 million was paid in wages and salaries, an increase of about 26% over 1997.

Decreases in Capture Fisheries

Today, Canada rates as a secondary player in the capture fisheries. In 1999, it was in twenty-second place in the world, with a production of 1,021,916 tonnes. This accounts for only a small percentage (1.1%) of global production. In 1990, Canada's ranking in world capture fisheries was much higher; it was ranked fourteenth in the world. The decline in the landing of Atlantic groundfish, notably cod, can partly explain this sharp drop. Another significant factor is the stong expansion of world aquaculture. In 2000, aquaculture accounted for 27.3% of world fisheries production (FAO, 2002). Historical seafood export figures also reveal that Canada has lost ground as a fish exporting nation since 1988. It was the leading fish exporting country between 1976 and 1987 (DFO, 2002). Canada has, nevertheless, remained among the top exporting countries. In 1999, it was ranked sixth in the world (Beaudin, 2001; FAO, 2002 and DFO, 2002).

Fish and Seafood Trade

Canada has remained one of the world's top seafood exporters. However, its rank has dropped, from third in 1990 to sixth in 1997. The fish and seafood export commodities account for almost 18% of national agri-food exports ($23.2 billion), bringing in earnings, in 2000, of $4.06 billion (459,976 tonnes), up 8.7% from 1999 (Agriculture and Agri-

Food Canada, 2002). Canadian aquaculture production continues to show the strongest advance of any sector within Canada's fish and seafood industry.

Canada's seafood sector is heavily export-oriented, with over 75 per cent of its fish and seafood production being exported to more than 100 countries around the world. The United States is Canada's largest market, followed by Japan, China, the United Kingdom and Denmark. In 2000, these five destinations collectively accounted for 87.1 per cent of the volume and 90.8 per cent of the value of total seafood exports or approximatively nine-tenths of Canadian production. The U.S continues to be the most important trading partner for Canada's fish and seafood products, accounting for approximatively 70 per cent of both the volume and value of exports. The aquaculture sector was a major contributor to Canada's success in exporting to the U.S. In 2000, fresh farmed Atlantic salmon ranked third overall in total value ($327 million), surpassed only by frozen crab ($360 million) and live lobster ($337 million). There was also an increase in shellfish exports to the U.S., of which a sigificant portion originated from aquaculture production (Agriculture and Agri-Food Canada, 2002).

Table 8 presents the exports of selected Canadian aquaculture products by country of destination between 1998 and 2001. In 1998, Canada exported 5,709 tonnes of mussels valued at $14.5 million. In 2001, it exported 8,516 tonnes of mussels valued at $22.3 million. Mussel exports increased 49.2 % in tonnage between 1998 and 2001. The average sale price for mussels was $2.54/kg in 1998 compared to $2.62/kg in 2001. In 1998, Canada exported 38,955 tonnes of Atlantic salmon worth $ 311.8 million while in 2001, it exported 50,575 tonnes worth $401.6 million. Salmon exports increased 29.8% in tonnage between 1998 and 2001. Atlantic salmon sold on average at $8/kg in 1998 compared to $7.94/kg in 2001.

In 2001, 99.2% of the blue mussels produced were exported to the U.S., mainly to the states of Maine and Massachusetts, which accounted for 78.6% of all U.S. sales by volume. That year, 96.3% of Atlantic salmon produced was also exported to the U.S., mainly to the states of Washington and California but also to Massachusetts and New York. In total, these four states accounted for 77.8% of Canadian Atlantic salmon exports (Table 8).

Aquaculture exports expanded substantially during the 1990s, more than doubling between 1992 and 2000. The United States is also Canada's biggest market for aquaculture exports. Between 1998 and 2001, 98% of the mussels and 96% of the salmon was exported to the United States with the remainder going to France, Japan and Taiwan. The Canadian Food Inspection Agency's (CFIA) export certification program provides exporters with official documentation that Canadian fish and seafood products sold on world markets will meet the requirements of importing countries. The Canadian seafood industry is seen in many countries around the globe as supplying top quality and wholesome products.

TABLE 7 – CANADIAN AQUACULTURE INDUSTRY VALUE-ADDED ACCOUNT (1998-2001)[1,2,3]	2001	2000	1999	1998
	'000 of dollars			
Gross Value-Added (factor cost)	**274,650**	**303,820**	**271,980**	**223,070**
Gross Output	738,900	776,470	697,435	564,680
Sales of Products and Services	675,230	692,500	611,430	520,100
Finfish	602,030	629,900	570,170	472,900
Shellfish	65,200	55,200	44,750	37,050
Other Goods and Services	8,000	7,400	6,510	10,150
Subsidies	1,970	2,170	2,020	6,800
Other Operating Revenue	27,300	28,200	27,865	13,030
Change in Inventory Value of Goods	34,400	53,600	56,120	24,750
Total Product Inputs[4]	466,350	474,450	431,505	338,640
Feed	191,825	189,350	177,000	141,250
Therapeutants	7,250	7,900	6,850	5,950
Purchases of Eggs and Fish for Grow-Out	51,675	58,100	49,310	41,000
Purchases of Fish for Processing and	72,550	75,000	68,550	40,400
Resale	8,450	8,700	8,125	7,400
Insurance Premiums	10,300	9,950	7,800	7,100
Energy	16,700	17,050	15,560	17,050
Transportation and Storage of Goods	33,050	31,950	29,760	29,300
Processing Services	5,550	5,300	4,180	3,700
Rental and Leasing Expenses	5,275	5,450	4,105	4,150
Maintenance and Repair of Buildings	11,775	11,350	9,960	8,150
Maintenance and Repairs of Machinery	8,300	8,100	7,545	5,040
Professional Services	43,650	46,250	44,230	30,950
Other Operating Expenses				
Selected Primary Inputs	92,500	90,000	85,800	73,300
Salaries and Wages	9,850	9,550	8,950	6,800
Employer Portion of Employee Benefits	31,700	31,150	29,500	25,550
Depreciation	15,800	16,950	15,900	14,400
Interest Paid				

1. The value-added account is experimental and should be used with caution. Data and the account structure are subject to revision. 2. Equals the sum of all provinces excluding Manitoba, Saskatchewan and Alberta. 3. Includes fish eggs and live fish; fresh, chilled and frozen dressed, whole fish; fresh and frozen fish fillets; and dried and smoked fish and fish in brine. 4. Equals all items less the Change in Inventory Value-Raw Materials. **Source:** Statistics Canada, CANSIM II, tables 003-0003 and Catalogue no. 21-603-UPE and 23-603-UPE

TABLE 8 – EXPORTS OF SELECTED CANADIAN AQUACULTURE PRODUCTS BY COUNTRY OF DESTINATION

DESTINATION	2001			2000			1999			1998		
	Mussels	Other Salmon	Atlantic Salmon	Mussels	Other Salmon	Atlantic salmon	Mussels	Other Salmon	Atlantic Salmon	Mussels	Other Salmon	Atlantic Salmon
	Tonnes			Tonnes			Tonnes			Tonnes		
United States	8,445	3,242	48,682	7,760	2,978	40,515	6,018	3,647	38,948	5,566	5,122	37,100
California	250	1,320	12,123	310	1,164	8,642	313	1,678	7,940	361	1,536	2,499
Maine	3,387	-	803	3,068	-	796	2,669	-	1,237	2,082	1	1,109
Massachusetts	3,308	87	6,884	2,821	4	8,787	1,959	9	8,475	2,088	75	7,808
New York	652	79	4,529	586	14	3,309	519	15	2,659	394	119	2,566
Washington	10	1,311	14,367	9	1,283	14,509	26	1,610	15,708	28	3,114	20,311
Other	838	445	9,976	966	513	4,472	532	335	2,929	613	277	2,807
France	-	-	-	24	-	-	166	-	-	143	-	8
Japan	63	44	466	45	193	191	-	360	474	-	63	755
Taiwan	-	64	1,295	-	2	767	-	-	603	-	19	978
Other	8	-	132	-	-	127	8	-	10	-	3	114
Total	**8,516**	**3,350**	**50,575**	**7,829**	**3,173**	**41,600**	**6,192**	**4,007**	**40,035**	**5,709**	**5,207**	**38,955**
	$'000			$'000			$'000			$'000		
United States	22,017	19,571	387,020	19,341	23,249	327,294	14,889	27,213	329,930	14,305	39,318	29,6326
California	802	8,077	10,9443	899	9,135	81,751	912	12,272	74,315	986	10,630	19,300
Maine	7,640	-	6,778	6,429	-	6,033	5,415	-	9,310	4,464	6	8,584
Massachusetts	9,146	356	48,262	7,524	28	68,276	5,462	55	66,106	5,806	466	64,032
New York	1,823	504	34,469	1,628	128	26,472	1,390	143	19,410	1,100	776	19,957
Washington	36	7,568	108,367	35	9,808	110,541	83	12,264	138,860	33	25,578	163,340
Other	2,570	3,066	79,701	2,826	4,150	34,221	1,627	2,479	21,929	1,866	1,862	21,113
France	-	-	-	97	-	-	573	-	-	186	-	75
Japan	264	314	3,585	201	1,890	1,557	-	3,749	4,088	-	610	6,516
Taiwan	-	494	9,972	-	14	6,208	-	-	4,899	-	148	7,822
Other	20	-	1,032	-	-	1,040	35	-	112	-	22	1,044
Total	**22,301**	**20,379**	**401,609**	**19,639**	**25,153**	**336,099**	**15,497**	**30,962**	**339,029**	**14,491**	**40,098**	**311,783**

Source: Statistics Canada

By way of comparison, Canada imported $2.08 billion worth of fish and seafood products in 2000, resulting in a trade surplus of close to $2 billion. A significant portion of the imports were products destined for purposes other than for human consumption; the bulk of imports in tonnage consisted of fishmeal, a key ingredient used in the preparation of livestock and fish feed. Although meal represented 32% in tonnage, it represented only 4% of the value of seafood products not destined for human

consumption. Since the severe decline in several groundfish stocks, processors have gradually sought to replace domestic supplies of fish with raw material imports through sources from around the world. Value is added to a significant proportion of these imports in Canadian processing plants and close to 35% is re-exported.

Description of the industry

World Ranking in Aquaculture

Canada is a small player on the world aquaculture scene. In 1999, it ranked twenty-second and accounted for only 0.3% of global production. Despite this low ranking in terms of volume, the average unit value of Canada's aquaculture products is particularly high, placing it fourth behind Japan, Chile, and Thailand (Beaudin, 2001). Aquaculture represents a growing percentage of the seafood production in this country. In 2001, aquaculture amounted to 12.7 % of the seafood industry production. In terms of value, the difference is still more remarkable; that year, aquaculture accounted for 25.2 % of the value of the seafood industry in Canada. In 1996, aquaculture represented 7.2 % of the seafood production and 18.5% of its value. In just five years aquaculture's contribution to the Canadian seafood industry increased by 76% in tonnage and 36% in value (Table 9).

Aquaculture and fisheries production, animal food and trade data for the period 1996 to 2000 are presented in Table 8. Canadian consumption of seafood is relatively small in comparison to that of countries such as Spain and Japan. In these countries, consumption is six to eight times higher than in Canada. In Canada, per capita fish consumption has remained relatively stable between 1996 and 2000, fluctuating between 8.3 and 10 kg/year.

Number and Distribution of Farms

Commercial aquaculture production takes place in every province and in the Yukon Territory. Trout production is primarily concentrated in the central provinces of Ontario and Quebec. The bulk of oyster production takes place in British Columbia and Prince Edward Island, and, to a lesser extent, in Nova Scotia and New Brunswick. Steelhead production takes place mainly in Nova Scotia and Newfoundland. Finally, while salmon production takes place mainly in British Columbia and New Brunswick, Nova Scotia and Newfoundland are also involved. Geographically, salmon and mussel cultivation are strongly localized. In British Columbia, most salmon farms are located in coastal areas of the mainland's Broughton Archipelago, while in Atlantic Canada, the largest concentrations are found in the Bay of Fundy. The bulk of the mussel industry is located in Prince Edward Island.

Aquaculture leasing and licensing data by province and in the Yukon Territory is presented in Table 10. In 2002, there were a total of 6,116 aquaculture licences, and 2,811 leases in Canada. There are 30,971 hectares of submerged Crown land leased

in Canada. Most of the leases and commercial licences are for marine shellfish culture. This category accounts for 46% (1,345) of commercial licences, 86% (2,413) of the leases and 68% (21,167 hectares) of the total acreage leased. New Brunswick has the largest number of aquaculture commercial licences (784) followed by British Columbia (675) and Quebec (508). There are only 12 leases, totalling 36 hectares for freshwater finfish culture. The bulk of these leases are for cage culture in Ontario (seven leases, 24 hectares). The largest number of leases are in P.E.I. (1,099), followed by New Brunswick (644) and British Columbia (538). These three provinces account for 81% of the leases in Canada. There are 164 commercial hatcheries in the country, with most of them being for finfish (144). It is interesting to note that the size of marine leaseholds in British Columbia, New Brunswick and Prince Edward Island are, on average, smaller than those found in Newfoundland and Nova Scotia. The largest average size of a marine leasehold is 25.8 hectares, in Newfoundland. This is followed by Nova Scotia (15.7 hectares) and New Brunswick (8.4 hectares). British Columbia and Prince Edward Island have the lowest average size leasehold at 6.6 hectares. It is also noteworthy that the average shellfish leasehold in each province is smaller in size than the ones for finfish (Table 12).

Business Size and Ownership

The aquaculture industry in Canada is composed of small and medium-sized enterprises as well as large-scale, vertically-integrated operations. In the last decade, restructuring and concentration has occurred in the aquaculture industry through mergers and acquisitions. This phenomenon has taken place mainly in the salmon industry and, to a lesser extent, in the mussel industry. The forces of global competitiveness have led to vertical integration and consolidation. The common belief in the industry is that the bigger you are the more profitable you will become.

The consolidation was a natural process for an emerging salmonid aquaculture industry trying to compete globally. This is particularly evident in British Columbia. Today, a smaller number of larger, vertically-integrated and more efficient firms are producing most of the province's farmed salmon (British Columbia Salmon Farmers Association (BCSFA), 2002). In 1989, the number of salmon farms in British Columbia peaked at 135 farms. These farms were owned by 50 companies. In 2002, the landscape has changed significantly. A small number of companies (12) own the 121 farms in operation (BCMAFF, 2002). The largest producer is Norwegian-based Stolt Seafarms. In 2000, five companies produced 82% of British Columbia's entire salmon production (Egan, 2001). This trend has not been so pronounced in the Bay of Fundy, New Brunswick, where about one-third of the total Canadian production of Atlantic salmon is produced. Corporate ownership is less concentrated in this area, where 40 companies operate 96 sites. P.E.I. is the largest blue mussel producer in Canada. The bulk of its output is processed in five mussel processing plants.

TABLE 9 – AQUACULTURE AND FISHERIES PRODUCTION, ANIMAL FOOD CONSUMPTION AND TRADE	2000	1999	1998	1997	1996
Aquaculture production					
Shellfish production (tonnes)	32339	27078	23976	17921	19071
Percentage of Canadian total	25.4	23.9	26.2	21.9	26.3
Shellfish farm-gate value ('$000)	52565	41057	34648	25741	28516
Percentage of Canadian total	8.8	7.4	8.1	6.7	8.0
Finfish production (tonnes)	94895	86150	67435	63842	53427
Percentage of Canadian total	74.6	76.1	73.8	78.1	73.7
Finfish farm-gate value ('$000)	547807	516847	394859	358664	326933
Percentage of Canadian total	91.2	92.6	91.9	93.3	92.0
Total production (tonnes)	127234	113228	91411	81763	72498
Total farm gate value ('$000)	600372	557904	429507	384405	355449
Percentage of seafood production	11.6	9.8	8.2	7.7	7.2
Percentage of seafood value	22.6	22.5	21.1	19.0	18.5
Fisheries production					
Nominal catches (tonnes)	973890	1039219	1019447	985273	933178
Landed values ('$000)	2061194	1924589	1610678	1634285	1565642
Seafood production					
Total production (tonnes)	1097814	1152447	1110858	1067035	1005676
Total value ('$000)	2672766	2482493	2040185	2018690	1921091
Seafood consumption					
Per capita supply seafood (kg/year)	24.6	24.7	24.1	22.6	24.0
Seafood as share of animal protein (%)	19.7	24.3	24.7	24.4	26.2
Per capita fish consumption (kg/year)	9.3	10.0	8.8	8.7	8.3
Trade in seafood commodities					
Total aquaculture imports (Can$ '000)	79355	66707	55583	48958	44496
Total aquaculture exports (Can$ '000)	388993	391973	373720	338664	262975
Aquaculture trade balance (Can $ '000)	309639	325266	318137	289706	218479
Total fishery imports (Can$ '000 000)	1599	1563	1475	1284	1314
Total fishery exports (Can$ '000 000)	2953	2746	2305	2173	2208
Fishery trade balance (Can $ '000 000)	1354	1183	830	889	893

Source FAO, DFO, Statistics Canada (1996-2000)

TABLE 10 – Aquaculture Leasing and Licensing Data by Province and Territory (2002)												
	NF	NS.	PEI	NB	QC	ON	MB	SK	AB	BC	YU	CAN
No. of Licences												
Commercial / Developmental	182	389	15	784	508	189	26	18	88	675	39	**2913**
MF	n/av	59	n/ap	96	1	n/ap	n/ap	n/ap	n/ap	121	n/ap	**277**
MS	104	273	n/ap	515	36	n/ap	n/ap	n/ap	n/ap	417	n/ap	**1,345**
MP	n/ap	2	n/ap	3	n/ap	n/ap	n/ap	n/ap	n/ap	n/av	n/ap	**5**
MSU	n/av	7	n/ap	6	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	**13**
MLP	n/ap	n/ap	n/ap	20	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	**20**
M	n/av	341	n/ap	640	37	n/ap	n/ap	n/ap	n/ap	538	n/ap	**1,660**
FF	n/av	48	15	144	471	189	26	18	88	137	39	**1,175**
F	78	107	15	240	472	189	26	18	88	258	39	**1,530**
Recreational / Private	n/ap	n/ap	n/ap	146	n/ap	n/ap	n/av	n/av	3052	n/ap	n/ap	**3,198**
Institutional / Research	16	n/ap	n/ap	4	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	**20**
Total	**198**	**389**	**15**	**934**	**508**	**189**	**26**	**18**	**3,140**	**675**	**39**	**6,131**
No. of Leases[1]												
MF	81	54	n/ap	96	n/ap	n/ap	n/ap		n/ap	121	n/ap	**352**
MS	113	268	1,099	515	1	n/ap	n/ap	N/ap	n/ap	417	n/ap	**2,413**
MP	1	n/ap	n/ap	3	n/ap	n/ap	n/ap		n/ap	n/ap	n/ap	**4**
MSU	n/ap	4	n/ap	6	n/ap	n/ap	n/ap	N/ap	n/ap	n/ap	n/ap	**10**
MLP	n/ap	n/ap	n/ap	20	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	**20**
M	195	326	1,099	640	1	n/ap	n/ap		n/ap	538	n/ap	**2,799**
FF	n/ap	n/ap	n/ap	4	1	7	n/ap	N/ap	n/ap	n/av	n/ap	**12**
Total	**195**	**326**	**1,099**	**644**	**2**	**7**	**n/ap**	N/ap	**n/ap**	**538**	**n/ap**	**2,811**
								N/ap				
								N/ap				
								n/ap				
No. of Hectares												
MF	N/av	1,966	n/ap	1,500	n/ap	n/ap	n/ap	N/ap	N/ap	1,191	n/ap	**4,657**
MS	N/av	3,095	7,275	3,600	4,840	n/ap	n/ap		n/ap	2,357	n/ap	**21,167**
MP	N/av	n/ap	n/ap	10	n/ap	n/ap	n/ap	N/ap	n/ap	n/ap	n/ap	**10**
MSU		n/ap	n/ap	20	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	**20**
MLP	N/ap	n/ap	n/ap	50	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	n/ap	**50**
M		5,061	7,275	5,180	4,840	n/ap	n/ap	n/ap	n/ap	3,548	n/ap	**30,935**
FF	N/ap	n/ap	n/ap	10	2	24	n/ap	n/ap	n/ap	n/ap	n/ap	**36**
	5,031							n/ap				
Total	n/ap	**5,061**	**7,275**	**5,190**	**4,842**	**24**	**n/ap**		**n/ap**	**3,548**	**n/ap**	**30,971**
	5,031							**n/ap**				
No. of Commercial Hatcheries												
Finfish	7	17	n/av	47	N/av	n/ap	n/ap	n/ap	N/ap	73	n/ap	**144**
Shellfish	0	4	n/av	0	1	n/av	2	5	n/av	7	1	**20**
Total	**7**	**21**	**n/av**	**47**	**1**	**n/av**	**2**	**5**	**n/av**	**80**	**1**	**164**

Sources: Marion Vezina - Nova Scotia Department of Fisheries and Aquaculture (NSDFA); Odile Légaré, Danielle Hébert, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ); Mark Muschett - Ontario Ministry of Natural Resources (OMNR); Al Martin, Evan Peel, Kathy Evans - BCMAFF; Lori Cuddy - (DFO); Barb Scaife - Manitoba Department of Conservation (MDC); Susan Thompson - Yukon Department of Environment (YDE); Tom Maher - Saskatchewan Department of Agriculture, Food and Rural Revitalization (SDAFRR); Jack Steward - Alberta Department of Agriculture, Food and Rural Development (ADAFRD); Peter Bourne - New Brunswick Department of Agriculture, Fisheries and Aquaculture (NBDAFA); and Claudette Oakes - Newfoundland Department of Fisheries and Aquaculture (NDFA).

1 – Terms other than lease are used to identify property rights, including Land Use Permit and Permit or Licence to Occupy.

MF – Marine Finfish; MS – Marine Shellfish; MP – Marine Plants; MSU – Marine Sea Urchins; MLP – Marine Lobster Pounds; M – Marine; FF – Freshwater Finfish; F - Finfish

Notes to Table 10

PRINCE EDWARD ISLAND

Prince Edward Island is unique in that it is the only province in Canada where the federal government is responsible for issuing leases and licences for aquaculture in waters under provincial jurisdiction. Fish farming licences are only required for the freshwater aquaculture sector.

NEW BRUNSWICK

Please note that acreage figures for marine shellfish and finfish sites are estimates. Lobster pounds are not licensed for aquaculture purposes by the province unless an alternate species is being grown.

QUEBEC

Normally, aquaculturists who occupy provincial Crown lands would be required by the Quebec Department of Environment under the *Watercourses Act, Public Domain Water Regulation*, to obtain a lease. However, the department tolerates occupation of such lands without a lease because of the current difficulties associated with issuing leases in the marine environment.

ONTARIO

The seven licences for cage culture operations are exclusively for the culture rainbow trout. There are 182 licences for land-based operations. Rainbow trout is by far the single most important species. Tilapia, Arctic char and a variety of other cold water and warm water species are also cultured. There are 66 single species licences, 49 two-species licences and 74 licences for three species or more. Most of these licences are either for food production or for stocking production. There are also a number of fee-for-fishing operations and private fishing clubs. In total, there are 12 licences issued to private fishing clubs, with the remaining 177 licences being commercial.

MANITOBA

The bulk of the aquaculture licences are for the production of rainbow trout. One or two licensees are stocking brook trout in Crown waters in the northern part of the province; however, production is minimal to non-existent. Two hatcheries are currently producing rainbow trout and Arctic char. One of them has also produced tiger trout, cheetah trout, spar and walleye. A few kilograms of brook trout have also been produced. All of these species have been raised primarily to stock fee-for-fishing ponds with no production being reported.

SASKATCHEWAN

In 2001, 13 licences for extensive (pond) aquaculture were in operation, averaging 2,000 rainbow trout fingerlings stocked. Total production from these ponds is estimated at 10 tonnes. There is only one cage culture licence. This operation produces about 1,200 tonnes of fish. There is one fingerling broker selling close to 70,000 rainbow trout fingerlings. Five hatcheries have imported a combined total of 780,000 rainbow trout eggs. Two fee-fishing licences have raised a total of 6,000 rainbow trout. One licence to cultivate brine shrimp is in operation. In addition, there are about 2,000 unlicensed hobbyists who produced an estimated 50 tonnes of rainbow trout.

ALBERTA

There are 81 commercial "A" licences and seven commercial "B" licences. The commercial "A" fish culture licence allows the holder to sell as well as keep cultured fish. The licence holder operates in prescribed waters (PW). PW are water bodies or contained waters that have as their source of water a municipal water supply, a well, or surface runoff; or water bodies that are completely surrounded by private land, or other land that is not public land under the *Public Lands Act*. A commercial "B" fish culture licence allows the holder to sell and keep cultured fish in contained waters (CW) only. CW refers to aquaria/tanks normally housed within a building or man-made reservoirs (dugouts) that have their water effectively isolated from flowing into another water source, are lined with an impervious material and are no larger than 600 square feet in surface area. With the exception of some provincially-run fish hatcheries, aquaculture operations are not permitted on public land. In Alberta, regulations allow the culture of Arctic char, brook trout, brown trout, rainbow trout, tiger trout, grass carp, Atlantic salmon, chinook salmon, coho salmon, sockeye/Kokanee salmon, freshwater prawns, goldfish, koi and tilapia. Four provincially-run freshwater finfish hatcheries are in operation.

BRITISH COLUMBIA

There are 14 companies holding the 121 tenures and licences for marine finfish. These companies are producing mainly coho, chinook and Atlantic salmon. There are also 15 commercial marine finfish hatcheries producing predominantly Pacific halibut and black cod. Lingcod and rockfish are also produced, but to a lesser extent. Two hundred and thirty-one companies operate 417 shellfish tenures.

YUKON

There are 16 licensed fish farmers in the Yukon Territory. In addition, 23 lakes have also been licensed for fish farming. All lakes are pothole lakes with no inlet or outlet and are free of any other species of fish. Currently, the licences are restricted to two species only. Fish farmers can stock either Arctic char or rainbow trout. There are two certified, disease-free commercial hatcheries in operation, both raising Arctic char. There is also one government-run hatchery raising chinook salmon, Kokanee salmon, bull trout, lake trout and Arctic char.

There are basically no restrictions on foreign ownership of businesses in the aquaculture industry in Canada. It is estimated that about 90% of the aquaculture businesses in Canada are Canadian-owned. However, this figure is misleading since it relates only to the number of businesses. When the tonnage and value of the aquaculture production is factored into the equation, the picture is totally different. Foreign businesses control the bulk of aquaculture production in Canada. The salmon industry, which consists of a blend of Canadian and foreign firms, has the highest level of foreign ownership.

Species Raised

A total of 69 cold-water aquaculture species are grown in Canada today. Species commercially cultivated include finfish (Atlantic salmon, steelhead trout, brook trout, rainbow trout and Arctic char), mollusks (Pacific and American oysters, blue mussels, Manila clams). A wide range of other species is also cultivated. These include species that have yet to be commercially successful but that have considerable market potential such as Atlantic halibut, haddock, cod, and flounder. There are also species that are already farmed successfully but for which production is limited by a poor understanding of key biological processes or by profitability such as American eel, sea scallop and northern quahaug (Table 11).

TABLE 11 - LIST OF LICENSED CANADIAN AQUACULTURE SPECIES

FINFISH		SHELLFISH	
Atlantic salmon	Short nose sturgeon	Blue mussel	Bar (Surf) clam
Coho salmon	Atlantic halibut	Pacific oyster	Soft-shell clam
Chinook salmon	Haddock	American oyster	Japanese scallop
Brook trout	Atlantic cod	European oyster	Green sea urchin
Rainbow trout	Striped bass	Northern (Bay) quahog	Bay scallop
Arctic char	Atlantic wolffish	Northern abalone	Island scallop
American eel	Specked trout	Sea scallop	Razor clam
Tilapia	Brown trout	Manila clam	Stimpson clam
Steelhead trout	Pollock	Ocean quahaug	
	American flounder	Northern propeller clam	
	Yellowtail flounder		
	Witch flounder	OTHERS	
	White sturgeon		
	Sockeye/Kokanee salmon	Bullfrog	
	Smallmouth bass	Northern leopard frog	
	Largemouth bass	Sea parsley	
	Chum salmon	Irish moss	
	Grass carp		
	Lake trout		
	Splake		
	Longnose sucker		
	White sucker		
	Atlantic sturgeon		
	Lake sturgeon		
	American crayfish		
	Northern crayfish		
	Walleye		
	Sauger pike		
	Channel catfish		
	Yellow bullhead		
	Brown bullhead		
	Tiger trout		
	Goldfish		
	Koi		
	Sole		
	Crownfish		
	Pacific halibut		
	Black cod		
	Lingcod		
	Rockfish		
	Pink salmon		

Sources: Marion Vezina – NSDFA, Odile Légaré, Danielle Hébert - MAPAQ, Mark Muschett- OMNR, Al Martin, Evan Peel, Kathy Evans – BCMAFF, Lori Cuddy – DFO, Barb Scaife-MDC, Susan Thompson, YDF, Tom Maher-SDAFRR, Jack Steward-ADAFRD, Peter Bourne-NBDFA and Claudette Oakes -NDFA.

Enterprise Types

Farming aquatic species in Canada encompasses a wide range of containment and rearing practices, spanning freshwater, brackish and marine environments. Although a multitude of aquaculture production systems can be found, they all fall within the following three broad types of production: stocking production, food fish production or fee-fishing operations. Interdital culture can be carried out on the near-bottom using rack and bags, cage and bags and bottom (beach) culture. Subtidal culture, commonly known as off-bottom or suspension culture, makes use of various types of containment structures such as socks, bags, cages, trays or tubes, which are either suspended from rafts of from various long-line systems. Land-based culture consists mainly of rearing in ponds, raceways, and tanks using either flow through or recirculation systems. Providing a description of each of these production systems is not within the scope of this study.

Table 12 – Average Marine Lease Sizes (In Hectares) by Province For All Species of Finfish and Shellfish

Provinces	Marine - All Species	Marine Finfish	Marine Shellfish
New Brunswick	8.1	15.6	6.9
British Columbia	6.6	9.8	5.6
Prince Edward Island	6.6	n/a	6.6
Nova Scotia	15.5	36.4	11.5
Newfoundland	25.8	n/avail.*	n/avail.*

* n/avail. : not available

Industry Organization

The Canadian Aquaculture Industry Alliance (CAIA) is an umbrella organization for the aquaculutre industry. It is a national industry association, representing the interests of Canadian aquaculture operators, feed companies and suppliers, as well as nine provincial aquaculture associations located in seven Canadian provinces. The Canadian Aquaculture Industry Alliance was formed in 1995 and replaced the Canadian Aquaculture Producers Council which was more narrowly representative of the aquaculture industry. Member associations of CAIA include:

- Aquaculture Association of Nova Scotia
- Ontario Aquaculture Association (OAA)

- New Brunswick Salmon Growers Association (NBSGA)
- Newfoundland Aquaculture Industry Association (NAIA)
- Prince Edward Island Aquaculture Alliance (PEIAA)
- Professional Shellfish Growers Association of New Brunswick (PSGANB)
- Syndicat professionnel de l'Association des Aquaculteurs du Quebec (SPAAQ)
- British Columbia Salmon Farmers Association (BCSFA)
- British Columbia Shellfish Growers Association (BCSGA)
- Aquaculture Association of Canada (AAC)

There exist also a number of sector or provincial industry associations not affiliated with CAIA. They include associations such as:

- Regroupement des Mariculteurs du Québec (RMQ)
- New Brunswick Aquaculture Association (NBAA)
- Alberta Fish Farmers Association (AFFA)
- Yukon Aquaculture Association (YAA)

CAIA provides a national structure and guidance to realize the full potential of aquaculture in this country. According to CAIA, it represents a strong, independent and united voice for the Canadian aquaculture industry. CAIA has three staff members: an executive director, a business manager and an administrative support officer. Its headquarters is in Ottawa.

CAIA undertakes a wide range of activities that include image and reputation building, broad-based education, advocacy, multi-stakeholder coalition building, coordination of member associations' advocacy efforts, and providing services to its members. The Alliance fosters a supportive environment for the Canadian aquaculture industry by fostering its international competitiveness, high levels of skill and knowledge within the sector, effective representation on industry issues and a positive industry image both domestically and internationally. It also promotes consumption of Canadian aquaculture products.

CAIA has been involved in several initiatives over the past few years. The Alliance carried out two comprehensive studies on the economic impacts of the federal regulatory framework on the industry. The Alliance was also responsible for the development of an aquaculture career and training directory, a functional analysis of the sector's training needs, an industry profile survey, skill standards development and a study of management salary and benefits. CAIA was instrumental in launching a science and technology youth internship program. A shellfish monitoring project was also initiated with the goal of developing a farm-based quality assurance program and investigation of commercial species as indicator species[3]. CAIA organized a workshop to discuss the National Aquatic Animal Health Program (NAAHP), which included elements of a comprehensive emergency disease eradication and compensation

[3] Indicator species: species that serve to provide early warnings that a community or ecosystem is being degraded.

program. Finally, it is responsible for the development of a draft National Code of Sustainable Aquaculture.

CAIA recognizes that human resources are an extremely important and integral part of a viable and competitive aquaculture industry. The economic and social success of the Canadian aquaculture industry will depend more than ever on its ability to recruit and maintain a skilled workforce. In partnership with HRDC and other industry partners, CAIA is dedicated to promoting human resource initiatives to further the growth and recognition of the Canadian aquaculture industry both nationally and internationally. CAIA formed a Human Resource (HR) Standing Committee in May 2000. The committee recently commissioned an aquaculture industry situational analysis and organized a strategic planning workshop to identify the human resource challenges facing the aquaculture industry and to establish a list of human resource priorities. Currently, the aquaculture industry in Canada is facing problems in terms of retention and recruitment of workers. The final report, *The Situational Analysis of the Aquaculture Industry of Canada* is now available (CAIA, 2002).

In the last few years, promoting best environmental practices through the establishment of codes of practice and their dissemination within the industry has been initiated in Canada. Several industry associations have developed codes of practice for their members' operations. Improving quality standards in the aquaculture industry through the development and implementation of codes of practice will encourage environmental sustainability and improve the sector's competitiveness. Currently, the following associations are developing and implementing such codes:

- The New Brunswick Salmon Growers Association (NBSGA) – Guidelines for Containment for Salmon Cage Culture in the Bay of Fundy and Environmental Monitoring Program;

- the Prince Edward Island Aquaculture Alliance (PEIAA)- Environmental Policy, and Codes of Practice and Communication Plan;

- the Aquaculture Association of Nova Scotia (AANS) – Aquaculture Environmental Management Guidelines;

- the Aquaculture Association of Ontario, the Alberta Fish Farmers Association, the New Brunswick Trout Farmers Association, and the Syndicat professionnel de l'Association des Aquaculteurs du Quebec – Environmental Codes of Practice for Freshwater Aquaculture in Canada;

- the British Columbia Shellfish Growers Association – Shellfish Aquaculture Code of Practice;

- the British Columbia Salmon Farmers Association – introduced a code of practice, and some companies are pursuing ISO 14000 environmental management certification. According to the B.C. Ministry of Agriculture, Food and Fisheries, the

salmon aquaculture environmental management regulatory standards implemented in British Columbia are the most comprehensive of any jurisdiction in the world.

- Implementation Plan and Code of Containment for Use of Non-Local Salmonids Strains in Sea Cage Aquaculture in Bay d'Espoir and Marine Cage Culture Code of Practice for the Newfoundland Aquaculture Industry.

Current Issues and Challenges

Table 13 presents a list of major outstanding issues and future challenges facing the Canadian aquaculture industry. The issues and challenges have been grouped to reflect the strategic elements identified by industry and other stakeholders during an OCAD consultation exercise. OCAD organized regional workshops in 2002 to consult stakeholders and to assist in crafting a long-term vision for aquaculture development in Canada and to define a renewed federal role to implement the vision.

TABLE 13 – List of the Canadian Aquaculture Industry Issues and Challenges

STRATEGIC ELEMENTS	CURRENT ISSUES / CHALLENGES	DESCRIPTION
ENVIRONMENTAL SUSTAINABILITY	*Aquaculture Impacts on the Aquatic Environment:* • *Impacts of solid organic waste (fish feces, uneaten feed and dead fish), biotic enrichment (eutrophisation), anoxic sediments, change in abundance and diversity of infaunal communities* • *Impacts of escapees on biodiversity and transmission of diseases* • *Use of fish meal and fish oil* • *Introduction of infectious diseases, through fish culture facilities and escapees to wild fish populations* • *Negative impact on biodiversity through fish escapement* *Other aquatic stakeholders' impact on aquaculture:* • *Introduction of diseases and exotics via ballast waters* • *Industrial, municipal and agriculture waste*	As is the case for other human activities, aquaculture can either have a positive or negative impact on the environment. Other stakeholders in coastal areas can also have a serious negative impact on aquaculture and the environment. Environmental groups and the general public are concerned over the growing environmental effects of the aquaculture industry. Negative impacts may depend on species cultivated, culture methods and location. Nevertheless, it is important to recognize that the aquaculture sector's viability is dependent on the maintenance of a healthy and productive aquatic environment. The challenge is to balance environmental, social and economic considerations. The use of risk management, the adoption of best management practices and the establishment of environmental standards are emerging as effective tools to ensure aquaculture is developed in a sustainable manner.

INTEGRATED MANAGEMENT	• *Access to sites* • *Public property rights* • *Conflicts over use of aquatic space (including those relating to navigation, recreation, riparian rights, tourism, fisheries, urban development, visual or aesthetic pollution and property devaluation)* • *Security of tenure (duration) and tenure size (economies of scale)* • *Bureaucratic delays and uneven application of the regulatory and policy framework* • *The duration of other authorizations such as those required under the Navigable Waters Protection Act (NWPA) and Canadian Environmental Impact Assessment (CEIA) approvals is not synchronized with tenure duration*	In Canada, the most important priority for advancing the aquaculture sector is the matter of access to sites. It is an issue in part due to conflicts between competing users for available space in coastal marine areas and public concerns over environmental issues. There is considerable competition between various human activities in coastal waters. Opponents of aquaculture, in particular environmental lobbyists and other user groups, notably, fishermen and landowners in coastal areas, have been effective in mobilizing public opinion and in influencing decisions by policy-makers with respect to access to sites. Governments may have difficulties in dealing with applications for aquaculture sites, as the decision-making process in many cases may be based on the exercise of political influence of competing users for aquatic space or of environmental groups rather than on economic principles such as net benefits to society. The allocation of aquaculture sites should be driven by the need to achieve the highest and best possible use of aquatic resources. Integrated Coastal Zone Management (ICZM) is an important tool that is available to solve user conflicts in coastal areas. The use of ICZM requires balancing a wide range of ecological, social, cultural, governance and economic considerations. Co-management is an important aspect of ICZM, whereby local stakeholders share aspects of governance with government. It is a means of making use of community participation as an essential part of the management process.
POLICY, LEGISLATION AND REGULATIONS	• *Legitimacy* • *Predator control* • *Access to seedstock and broodstock* • *Fishery sub-sector within the capture fishery* • *Competitiveness* • *Investment climate*	DFO is the lead federal agency for aquaculture development in Canada. The current regulatory framework whereby aquaculture operates does not take into account the way the industry operates and it is therefore a significant impediment to the development of aquaculture in Canada. An enabling regulatory framework and, consequently, a more favourable climate for developing aquaculture businesses would allow the industry to compete more effectively on the international scene. The business climate is often an important element in decisions by companies to invest or not in the aquaculture sector.

ABORIGINALS AND AQUACULTURE	• Treaty rights and land claims • Training • Capacity building and partnership	The number of First Nations involved in aquaculture has been increasing in the last few years. First Nations are turning to aquaculture to create opportunities for their members. The aquaculture jobs generated within First Nations communities are a source of community pride, economic growth, sustainable employment and job diversification.
RESEARCH, DEVELOPMENT AND TECHNOLOGY TRANSFER	• *Biotechnology and Genetics* • *Nutrition and Feeding* • *Invasive Species* • *Fish Health (stress, disease resistance, vaccine utilization)* • *Habitat* • *Carrying capacity* • *Fish escapement (impacts on wild stocks, containment)* • *Grow-out* • *Food safety* • *Waste recovery* • *Land-based aquaculture* • *Access to more fish vaccines* • *Access to more performing strains of fish and shellfish*	Scientific research is essential to adequately respond to consumer health and safety, environmental sustainability and social concerns. Research is required to separate fact from fiction, reality from perception. Scientific knowledge is also the driving force behind competitiveness in that it can contribute to it by enhancing productivity and profitability of the aquaculture industry. The identification of regional and national priorities for research and development, the optimization of human and financial resources through collaboration and partnership between academia, industry and government, are all crucial factors in building a sustainable and competitive aquaculture industry.

FINANCE, INDUSTRY DEVELOPMENT AND INFRASTRUCTURE	*Internal Factors* • *Technological farm productivity improvements* • *Cost and quality inputs (feed, labour, seedstock)* • *Marketing (advertising and promotion, product quality and customer service)* • *Economies of scale (size of tenure)* *External Factors* • *Domestic and foreign government assistance (access to financing, such as investment and working capital funds, access to infrastructure such as wharves, roads, electricity, risk management programs and association funding)* • *Regulatory environment* • *Trade policies*	The Canadian aquaculture industry needs a more favourable climate for developing aquaculture businesses. A supportive legislative and regulatory framework coupled with appropriate programs and services and required infrastructure to meet industry growth will lead to enhanced productivity, increased industry competitiveness and environmental sustainability. Two important indicators which can be used to measure the state of the aquaculture industry are increased profitability and increased market share.
MARKETING AND TRADE	• *Price destabilization of fish and seafood markets* • *Distribution channels* • *Food security* • *International trade barriers (tariff and non-tariff)* • *Labelling* • *Market access and requirements* • *Profitability* • *Value-added products* • *Environmental sustainability* • *Market intelligence* • *Diversification of products* • *Dumping* • *Trade dispute resolution* • *Phyto-sanitary* • *Price trends*	Seafood in Canada is a valuable earner of export credits as Canada exports to more than 100 countries. World markets are highly competitive and some countries have used discriminatory tariffs on trade to protect their domestic markets. Seafood exporters must meet international food safety and quality standards. Aquaculture is a market-driven industry that is closely tied to consumer demands, of which environmental and social concerns are at the top of the list. Marketing success is largely dependent on competitive prices, generic marketing, product promotion and market intelligence.

FOOD SAFETY	*Natural Environment Biological Hazards* • *Pathogenic micro-organisms (bacteria and viruses)* • *Marine biotoxins (Paralytic Shellfish Poisoning (PSP), Diarrhetic Shellfish Poisoning (DSP), Amnesiac Shellfish Poisoning (ASP)* *Introduced Husbandry Practices and Feed Manufacturing Chemical Hazards:* • *Antibiotic and pesticide residues* • *Persistent organic pollutants (furans, dioxins, PCBs)* • *Heavy metals (mercury, cadmium, lead)* • *Use of genetically modified ingredients in fish feed* • *Food additives such as pigments, hormones, vitamins and mineral supplements in animal feeds* *International Standards* • *Product traceability* • *Eco-labeling* • *On-farm Hazard Analysis Critical Control Point (HACCP)* • *ISO standards* • *Mandatory country-of-origin labeling*	Food safety deals with impacts on human health and improved safety of consuming aquatic cultivated products. The goal is to reduce seafood-borne illnesses. Worldwide, there are over 250 types of illnesses that have been described as being transmitted through food. The food supply in Canada is one of the safest in the world. Despite this high level of safety, Health Canada estimates that each year more than one million cases of foodborne illness are reported. These cases represent an estimated cost of close to one billion dollars to Canadian taxpayers. As is the case for any other food commodities, fish and seafood can cause illness in humans. However, to puts things in perspective, the occurrence of seafoodborne illnesses is substantially lower than for beef, poultry, and pork. Drug residues in farmed products are of particular concern to consumers. Potential adverse consequences for humans include allergic reactions, toxic effects or increased antibiotic resistance in pathogens that affect humans. For aquaculture, adherence to prescribed withdrawal periods is essential in assuring that no harmful residue remains in the flesh after use of chemotherapeutants. Public scrutiny of the role of the fish feed industry in animal production is also emerging.

AQUATIC ANIMAL HEALTH	• Animal welfare • Disease outbreaks, eradication and compensation • Unjustifiable trade barriers • Best Management Practices • Harmonization of legislation • Restrictions on movements of live animals • Limited number of approved antibiotics • Drug residues and development of antibiotic-resistant pathogenic organisms	Effective policies, legislation and guidelines regarding aquatic animal health are important to aquaculture development in Canada. Controlled movements of indigenous and exotic live aquatic animals are of significance in reducing potential ecological, genetic and disease risks associated with such movements. The introduction and spread of pathogens can cause serious disease outbreaks and result in catastrophic economic losses. A balanced national aquatic animal health program must strive to reduce the risk of disease and pathogen transfer while trying to avoid the imposition of barriers on aquaculture development and trade that are not justified. The limited number of approved antibiotics available to the Canadian aquaculture industry constitutes an important impediment to its development and expansion, which has a negative effect on its competitiveness in the global marketplace. Factors that restrict the number of available drugs for aquaculture include limited sales potential for pharmaceutical companies compared to drugs for other markets such as human medicine and the agriculture industry, as well as the high costs associated with the approval process of a new drug. In Canada, a total of nine drugs are approved for use in aquaculture.

COMMUNICATIONS AND TRAINING	• Public acceptance of aquaculture • Aquaculture data base • Ability to recruit and maintain a skilled workforce	The importance of effective communications within the sector and the public in general to improve the image of aquaculture cannot be over-emphasized. Communication is essential to raise consumer and public awareness regarding aquaculture. Moreover, it can be used to minimize multi-user conflicts and to respond to criticism from environmental NGOs. The aquaculture sector needs to establish a meaningful dialogue with all stakeholders if it wishes to improve its public image. It should be proactive in getting its message out and in responding to critics with facts. An effective communication strategy is required, which should include key messages, audiences to be targeted and a range of communication tools to be used in its implementation. Aquaculture is a complex industry. Training is a critical element of its development. Training may take many forms, from workshops to higher education programs. Training will help meet the needs of the people who work in the industry, as a range of skills and competencies is required to remain competitive and address changing conditions.

PART 2

POTENTIAL OF THE CANADIAN AQUACULTURE INDUSTRY

POTENTIAL OF THE CANADIAN AQUACULTURE INDUSTRY

Biophysical potential

Canada is one of the major maritime nations in the world, with a coastline 243,792 km long. This represents 25% of all coastline in the world. Three oceans - Arctic, Atlantic and Pacific, surround the country. Canada is also blessed with an abundance of bodies of fresh water. It possesses 16 per cent of the world's fresh water, representing more than 755,000 square kilometres. There are at least three million lakes in the country, including the Great Lakes and four of the 14 largest lakes in the world (DFO, and Agriculture and Agri-Food Canada, 2002).

Canada is blessed with an availability of suitable sites for raising aquatic animals in pristine habitats. Species are being cultivated in a very clean, unpolluted environment. Because of the availability of clean water inland and in the marine environment, the biophysical potential for aquaculture in Canada is tremendous. Canada's marine environment is extremely diverse, reflecting the different physical features of the coastal regions. Canada has one of the most diversified coastlines ranging from shallow bays to deep fjords, many of which are free of ice cover all year round. Moreover, the diversity of its geographic areas and environments facilitates raising a range of different species. Currently, 74 species are approved for rearing in aquaculture operations across the country.

Looking to the future, there is little expectation that in the year 2050, world population requirements for protein will come from capture fisheries. It is anticipated that global warming will modify the nature of commercial fishing and probably cause greater instability in the annual supply of marine fish. Conversely, aquaculture may benefit from climate change if the expected increases in agriculture production from global warming can be combined with research to use plant protein in aquaculture feeds. Aquaculture may be better able to adapt to global warming than traditional commercial fisheries because sites may be moved and due to the flexibility to change the species being cultured (Beamish and Noakes, 2002).

The aquaculture industry in Canada is making use of a relatively small surface area, as illustrated in the examples that follow. In the salmon farming area of Alberni-Clayoquot Sound, in British Columbia, the industry generates in excess of 250 direct jobs. The yearly production of cultured salmon is over 11 million pounds, valued at more than $39 million. It is remarkable that the salmon farms generating such wealth occupy only 0.0002 percent (2/100 of 1%) of Clayoquot Sound (British Columbia Salmon Farmers Association, 2002). On Prince Edward Island, the mussel industry occupies a total of 4,498 hectares of submerged Crown land. This may be compared to the 7,000 hectares covered by Montreal's Dorval Airport. The entire salmon farming industry in British Columbia takes up 1,191 hectares. It is smaller than than the Vancouver International Airport, which covers an area of 1,340 hectares.

A modest increase in submerged Crown lands allocated to aquaculture leases would allow the sector to expand, be more competitive and maintain market share in the U.S. A comprehensive study of the economic potential of the aquaculture industry in British Columbia, carried out by Coopers and Lybrand, concluded that the industry could become one of the province's most valuable industries in less than a decade. It indicated that potential revenues of $1 billion could be generated in a four-kilometre square area. With respect to the shellfish industry, it estimated that simply by doubling the current shellfish tenure acreage in the province, up to 1,000 new jobs could be generated with a related annual increase in farm gate value from the current level of $15 million to $100 million. In fact, doubling the shellfish culture acreage is the objective of the B.C. government's existing Shellfish Development Plan.

During a strategic planning workshop for aquaculture, held on August 19-21, 2001, a group of government and aquaculture industry experts gathered and addressed the task of forecasting production levels, in terms of value and tonnage, for the Canadian aquaculture industry in the year 2010. Using very conservative assumptions, they predicted that "the Canadian aquaculture industry will likely grow from its current revenue level of $700 million to at least $3.1 billion in 2010, provided that there was an an enabling policy and regulatory environment (Figure 4).

These projections are based on two key assumptions. Firstly, that the Canadian aquaculture industry would be supplying the projected increase of 15% in U.S. import markets for farmed-raised finfish and shellfish. Secondly, Canada will maintain its current market share in the U.S. of close to 45%. Combined with the supply and services industry, the aquaculture sector could generate, in 2010, total revenues in excess of $6 billion. It is estimated that additional salmon production of 350,000 tonnes could be generated if 66 new salmon sites were approved. These sites would have a total surface area of about 12 hectares. This estimate takes into account single-year class stocking and fallowing (OCAD, 2001b). The current average size of salmon sites in New Brunswick and in British Columbia is 15.6 hectares and 9.8 hectares respectively.

Sea ranching of shellfish species such as sea scallop, soft-shell clam, green sea urchin, American oyster, Northern quahaug, geoduck, Manila clam, Northern abalone and Japanese scallop also offers significant economic potential for development in Canada. A recent study on the economic potential of sea ranching, based on the biophysical potential of these nine species, showed that shellfish sea-ranching could provide significant economic and social benefits. Shellfish sea ranching could generate annual landed values of $1,255 million and overall direct impacts of 15,000 person years and $900 million in GDP. It should be noted that these figures have wide confidence limits, should be interpreted with caution and are indicative rather than definitive with respect to the economic potential of shellfish sea-ranching in Canada (Gardner Pinfold and IEC International, 2001).

Potential Expansion of Aquaculture Businesses

Canada's productivity for major aquaculture commodities productivity is presented in Table 14, based on amount produced, lease area and time (kg/ha/year). There exists a wide range in productivity for the same species between provincial jurisdictions. In some areas, there are opportunities to improve aquaculture site productivity within ecological limits for a particular species such as oysters in New Brunswick and mussels in Newfoundland and Labrador.

TABLE 14 – AVERAGE AQUACULTURE PRODUCTIVITY FOR MAJOR AQUACULTURE COMMODITIES AND PROVINCES (2000)[1]

SPECIES/ PROVINCE	PRODUCTIVITY (kg/ha/year)
Mussels – Prince Edward Island	7,957
Mussels - Newfoundland	599
Oysters – New Brunswick	413
Oysters – British Columbia	5,006
Salmon - New Brunswick	33,333
Salmon – British Columbia	82,955

1. Figures calculated from total provincial acreage and tonnage for each species.

Box 1

EXECUTIVE SUMMARY OF A REPORT

PREPARED BY Brian Rogers, Rogers Consulting Inc, (2002)

ON COD AQUACULTURE IN CANADA

A Vision to 2017

"In world seafood markets codfish, particularly Atlantic cod *Gadus morhua*, have been in high demand for hundreds of years. With Canadian stocks at historical lows, the great northern cod stock is presently at 1% of its all time high in the 1960's, supplying world markets has been impossible. The future outlook for wild stocks is not encouraging".

"Over the past 15 years in Canada, Norway and Scotland, advances have been made with cod culture to the point that it is now regarded as the aquaculture species of opportunity. Canada has been the domain of the largest wild cod stocks in the world and as such is seen as an excellent place for cod aquaculture. The Atlantic cod has been the dominant species of the wild stocks but from an aquaculture point of view there are opportunities for both Atlantic cod and Pacific cod."

"To maximize the potential for cod we need to review Canada's success with salmon culture. The key to the success of Atlantic salmon aquaculture has been in understanding the lifecycle to the point of establishing routine and predictability. Establishing this routine allowed the development of predictable business models. The assumptions in this report are based upon establishing similar routine and predictability for the farming of cod. The growth cycle from egg for producing 4kg market cod is well established at 32 months or less. Cod aquaculture is ready for focused research and predictable development."

"The major constraint to the development of the industry is the availability of cod juveniles. Focused development in establishing cod hatcheries and producing cod juveniles is required immediately."

Cod farming in Canada could be substantial. A conservative estimate of the future potential of the industry indicates that by investing $102 million of direct capital investment for the construction of six hatcheries and 40 nursery and grow-out farms a total of 128 000 tonnes of cod could be produced worth $545 million.

Know-how and expertise in international markets

Processing

The fish and seafood processing industry in Canada has gained international recognition over the years. Canada has become a world leader in processing a wide range of species notably, lobster, salmon, sablefish, crab, geoduck, mussels and salmon. This world class reputation is the result of the adoption new technologies and the development of innovative products. Moreover, Canada is also a major player in the processing of fisheries by-products such as chitin, chitosan and polymer chemicals. These emerging food ingredients and industrial products are used in many industries, notably pharmaceuticals and water treatment (Canadian Exporters Catalogue, 2002), as mentioned in Study no. 7 *Market Outlook in the International Fish and Seafood Sector Alternative Products/Uses and Food Safety Issues*, H.M. Johnson and Associates, 2002.

In 1998, the seafood products industry represented close to 5.5% ($2.9 billion) of total manufacturing for food industries produced in Canada (HRDC, 2000). Even though aquaculture is gaining in importance as a source of seafood, a large portion of it is still marketed unprocessed. The larger fish processing plants have their own fishing fleets and more and more of their raw material requirements are from this source. Nevertheless, the bulk of raw material is still obtained through contracts with independent fishermen and prices are normally negotiated by fishermen's organizations.

In 1999, the fish processing industry accounted for 0.4% of total goods GDP but represented only 0.12% of all Canadian industries. Over the last 12 years, the fish processing industry, which is composed primarily of small firms, has declined by 15%. The number of processing establishments in Canada (active and inactive – 1999) involved in seafood product preparation and packaging by size of workforce, category and province is presented in Table 15. In Canada, most enterprises consist of a single establishment (plant). In 1999, there were close to 3,459 establishments (active and inactive) in Canada involved in seafood product preparation and packaging. Almost 44% of the establishments are not considered to employ any individuals as they are operated by the owners who are not considered to be employees. However, these establishments may still have workforces consisting of contract workers, part-time employees, family members or the business owners. For the purpose of income tax, none of these are considered to be employees. Close to 2,000 establishments maintain employee payrolls, with most of them (44.8%) employing fewer than 19 individuals. There are 349 establishments with more than 99 but fewer than 199 employees, and 49 establishments with between 200 and 499 workers. Only a small number (eight) of processing plants have more than 500 employees. The largest enterprises play a significant role in the industry. In 1995, the eight largest firms operated 9% of the plants and processed about a third of the industry's shipments.

More than 35,000 workers are employed in the seafood processing industry, with women making up more than 50% of the workforce. The industry operates on a seasonal basis and is concentrated on the East and West coasts of Canada (HRDC, 2002).

Between 1988 and 1996, the number of fish processing plants and employment therein declined from 453 plants employing 20,000 full-time equivalent (FTE) workers to 417 plants employing an estimated 18,600 workers (DFO, 2002). Employment in selected aquaculture processing plants in Canada is provided in Table 16.

Better communications tools such as on-line trading, coupled with improved processing, freezing, storage and transportation technologies have been implemented in the industry. Most processors serve as intermediaries, for trade in a variety of fish products, with trading partners or subsidiaries in foreign countries. Moreover, the industry now processes a greater variety of species than in the past and has developed a wider range of products.

The major factors influencing the processing industry in Canada are economic, regulatory, social or demographic in nature. The drastic decline in the domestic groundfish fishery in Atlantic Canada and similar problems on West Coast, mainly from the collapse of wild salmon stocks, has led to restructuring in the industry. Massive downsizing, an increase in the import of raw material and changes in shellfish processing to methods that are less labour-intensive, as well as species diversification have resulted in a sharp decrease in employment in the processing and in the addition of value to finished products.

The food inspection regime has also changed in recent years, with a greater emphasis being placed on food safety. Increased responsibility put on processing companies has meant increased investment in training, and implementation of new technology to meet international safety standards. The downsizing of both the fishery and the processing sector was, in large part, dependent on federal government funding in retraining and economic development. In addition, the federal government instituted The Atlantic Groundfish Strategy (TAGS) licence buyback program in 1994 to reduce the size of the fishing fleet and the pressure on fish stocks. At the same time, demand for Canadian fish products has been rising in Asian countries.

Distribution Chain

In the United States, food products are most often sold by food brokers who resell them to supermarkets. Brokers provide after-sales services. Wholesalers coordinate storage and handle distribution, shipping and delivery of goods. The fish and seafood distribution networks in the United States consist mainly of three channels, notably brokers, wholesalers and retailers. Generally speaking, broker commissions are the lowest at 7%, followed by those for wholesalers (10%) and retailers (35%). Wholesale clubs and retailers are emerging as important buyers. Today, they represent the most

important buyers from processors located in Atlantic Canada. Distribution networks in the United States vary to a great extent from one region to another, mainly because of different consumption patterns. It is primarily wholesalers (76%), followed by processors (19%) and fishery companies (5%) that distribute imports of seafood products within the United States (Beaudin, 2001). Similarly, these groups influence sales domestically as well as exports to the U.S market, especially in terms of packaging, price and advertising.

Table 15 – Seafood Product Preparation and Packaging
Number of Establishments in Canada (Active and Inactive – 1999)
By Size of Workforce and Province

Province/ Territory	0	1-19	20-49	50-99	100-199	200-499	500+
Alberta	8	8	0	0	0	0	0
British Columbia	223	189	25	27	11	5	1
Manitoba	20	21	2	1	0	0	0
N.W.T. / Nunavut	4	7	0	0	0	0	0
New Brunswick	199	223	23	12	21	13	0
Newfoundland	199	194	26	25	22	16	6
Nova Scotia	579	668	50	13	21	9	1
Ontario	60	50	7	3	2	0	0
Prince Edward Island	81	79	10	2	5	3	0
Quebec	131	110	17	12	12	3	0
Canada	1,504	1,549	160	95	94	49	8
Distribution (%)	43.5%	44.8%	4.6%	2.7%	2.7%	1.4%	0.2%

Source: Industry Canada, 2002

Proximity to U.S. and Asian markets

Canada has easy access to the huge North American and Pacific Rim fish and seafood markets. Its southern neighbour, the United States, is its largest export market. The proximity of Canada to U.S. aquaculture and seafood markets is clearly advantageous in terms of freight costs and maintaining continuity of supply. The relative low value of the Canadian dollar is a further favourable condition for export (Brown and Stechey, 1997 and Industry Canada, Foreign Affairs and International Trade, 2002).

After the terrorist attacks of September 11, 2001, air cargo prices rose significantly, with more stringent aircraft security resulting in increased transport costs of almost 20 per cent. Nevertheless, because of its close proximity to the U.S., the Canadian salmon farming industry may be subject to less pressure on its margins with respect to exports to the U.S. compared to that experienced by its Chilean counterparts. The events of September 11, 2001 have resulted in a number of changes in world politics and economies as the aftershocks were felt in countries worldwide. While the economic situation has improved greatly in the first quarter of 2002, the events have had a significant impact on seafood exports. Key issues in this regard are the open border between the U.S. and Canada, ensuring national security and that measures taken at the border do not impede trade and investment. One of the biggest concerns has been the perception that Canada is a security risk.

Terrorism in the U.S. caused a slowdown in the seafood industry in Atlantic Canada. One New Brunswick seafood processing plant was closed temporarily because its products were stopped at the border. Initially, it was feared that Atlantic Canada alone could lose up to 23, 000 jobs as a result of the September 11 terrorist attacks. This downturn was anticipated because of a sharp decrease in the consumption of seafood in U.S. restaurants, reduced access to air transport and more complicated border crossing for truck transport of wild and farmed seafood products. Fortunately, these predictions did not materialize.

Expertise and reputation in environmentally sustainable technologies and practices

Public concern over the state of the environment and related regulatory requirements, together with efforts to respond to these concerns have led to the emergence of an environmental industry in Canada. Its success has been remarkable. In a relatively short time Canada has been able to position itself as an international expert with a solid reputation in the fields of environmental science and engineering technology to address environmental questions and sustainable development. Canadian firms possess recognized strengths in such traditional sub-sectors as water and wastewater treatment systems, handling of liquid and solid wastes, oil spill management and emergency response, instrumentation, and environmental equipment (Industry Canada, 2002).

It is estimated that Canada's environmental industry comprises 4,000 small and medium-sized enterprises as well as a number of larger corporations. They provide a

range of technologies, products and services in the areas of air pollution and control, water treatment/management, instrumentation and analysis, waste management, consulting, engineering processes and prevention technology. The global environmental market is estimated to exceed $700 billion while the Canadian market was worth $20 billion in 1997, or 2.2% of GDP. Environmental companies in Canada represent a significant part of the national economy. With an employment level in excess of 120,000 people, the sector represents the third largest employer after pulp and paper and the chemical industry (Industry Canada and Canadian Environment Industry Association 2002).

Table 16 – Employment Figures in Selected Aquaculture Processing Plants

Plant Name	Location	Species	Number of Employees
Calkins & Burke Ltd.	Vancouver, B.C.	Salmon	40
True North Salmon Company	St. George, N.B.	Atlantic salmon	75
Oven Head Smokers	St. George, N.B.	Atlantic salmon	4
Cooke Aquaculture N.B.	St. George, N.B.	Atlantic salmon	485
Jail Island Aquaculture	St. George, N.B.	Atlantic salmon	70
Heritage Salmon Co. Ltd. B.C.	Richmond, B.C.	Salmon	150
Atlantic Silver Inc.	St. George, N.B.	Atlantic Salmon	60
Stolt Sea Farms	St. George, N.B.	Atlantic Salmon	250
Prince Edward Aqua Farms	Kensington, P.E.I.	Mussels, oysters, quahogs, clams	25
P.E.I. Mussel Farms Inc.	Morell, P.E.I.	Mussels , oysters	40
Atlantic Aqua Farms	Orwell Cove P.E.I.	Mussels, clams, quahogs, oysters	33
Indian Point Marine Farms	Mahone Bay, N.S.	Blue mussels	5
Fanny Bay Oysters	Union Bay. B.C.	Pacific oysters, Manila clams	100

Sources Agriculture and Agri-Food Canada, Beaudin, 2001

According to the Canadian Environment Industry Association, countries typically go through seven stages in their evolution toward sustainable environmental development (Table 17). The Association has found that Canada is approaching stage seven, in that it is developing a sense of environmental responsibility and putting it into practice through the creation of integrated environmental management systems.

Table 17 - Stages in a Country's Evolution Towards Sustainable Environmental Development

STAGE	CHARACTERISTICS
1	Public awareness and pressure
2	Government policy stated
3	Legislation enacted
4	Regulations promulgated and agency empowered
5	Enforcement creates market for environmental firms (pollution control, cleanup and waste management)
6	Proactive effort to circumscribe regulation and liability (pollution prevention)
7	Internalization and integration of environmental efforts (sustainable development).

Source: Canadian Environment Industry Association, 2002

Canada excels in the development of aquaculture technologies, products and services, with key areas of expertise being aquatic animal health management, broodstock development, husbandry techniques, containment technologies, water management and environmental effects of aquaculture operations on fish habitat and aquatic ecosystems (Canadian International Development Agency, 1998 and Industry Canada, 2002). It is committed to being recognized as an international leader in sustainable development of aquaculture. Continued development of this expertise will provide an excellent opportunity to position Canada as a model of sustainable aquaculture and allow aquaculture to become one of Canada's sub-sector industries.

CONCLUSIONS

The Canadian aquaculture industry has matured over the years and has achieved tremendous growth over a relatively short period. However, this growth has to be put into perspective. If we compare Canada to other leading aquaculture jurisdictions such as Chile, it becomes evident that Chile's production figures are substantially greater. In fact, Canada could have made greater progress if it had benefited from a more enabling business climate.

By contrast, the domestic capture fishery sector has witnessed the collapse of groundfish stocks, notably cod. Consequently, Canada has lost its long-time dominant ranking as a major seafood-producing nation and has lost ground as a leading seafood trading nation. Aquaculture represents a growing percentage of total domestic seafood production. Increases in both finfish and shellfish aquaculture production have strengthened the seafood industry and help Canada maintain a relatively high ranking as a major seafood exporter.

Globally, the future of aquaculture appears to be bright and that of the Canadian industry is no different, according to a group of government and aquaculture industry experts. The group gathered during an aquaculture strategic planning workshop on aquaculture held in Merrickville, Ontario on August 19-21, 2001. It was tasked with forecasting production levels (value and tonnage) for the Canadian aquaculture industry in the year 2010. Participants at the workshop reached a consensus.

Using very conservative forecast assumptions they predicted that "the Canadian aquaculture industry will likely grow from its current revenue level of $700 million to at least $3.1 billion in 2010, provided that an enabling policy and regulatory environment is established (Figure 4).

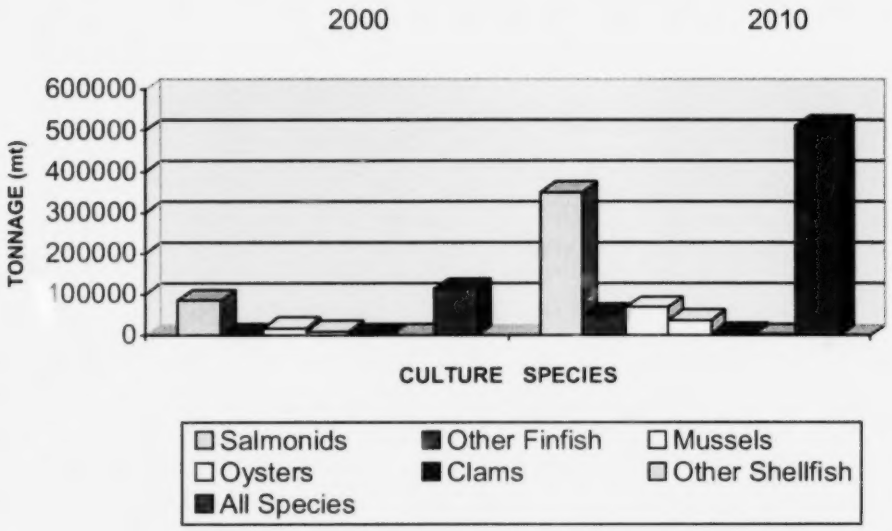
Unfortunately, Canada has not been able to capitalize fully on its strengths and opportunities in the way that other leading industrialized nations involved in aquaculture, such as Norway, Chile, and Spain have done.

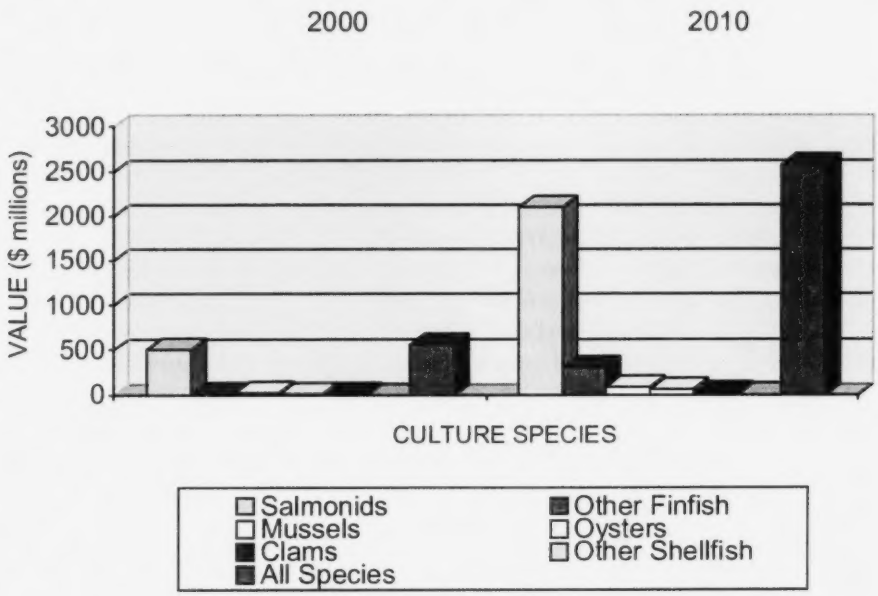
To become a successful and dynamic sector that is able to withstand strong international competition, the industry, in collaboration with governments, must explore new ways of doing business, move in new directions and respond successfully to emerging challenges. To remain vibrant, aquaculture in Canada must be able to prosper. At the same time, greater emphasis must be placed by the sector on acquiring its social licence.

There is a need for a rigorous assessment of the economic potential and social/environmental costs and benefits of future growth of aquaculture. In continuing to move forward, aquaculture should not cause unacceptable hazards to consumers or the

environment. In fact, this would be counterproductive and translate into diminished economic and other benefits related to aquaculture.

FIGURE 4 – CANADIAN AQUACULTURE INDUSTRY PRODUCTION
(Tonnage and Value) IN 2000 AND POTENTIAL IN 2010 BY SPECIES





Aquaculture can clearly contribute to a prosperous domestic fish and seafood industry. If Canada is to regain its status as one of the leading producing nations, both the fisheries and aquaculture sectors must collaborate more closely. Aquaculture can help better position the country on the international scene as a major producer and exporter of fish and seafood. The Canadian aquaculture industry continues to experience substantial rates of growth. Between 1997 and 2001, Canadian aquaculture production grew on average at a rate of 17 %. There is a growing sense, however, that much more needs to be done to ensure that aquaculture will develop in an environmentally safe manner.

For Canadian aquaculture to meet the challenge of achieving its potential, there must be a framework in place that satisfies not only traditional investment criteria but also public expectations for sustainable development. If this can be achieved, Canada would be a leader in having an aquaculture industry that has earned its social licence by respecting the environmental, social and cultural concerns of its neighbours.

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